JANUARY 1958

Power Engineering

ATOMICS ..... Special Bi-Monthly News Report From the Field 33

Annual Review of WORLD POWER DEVELOPMENTS

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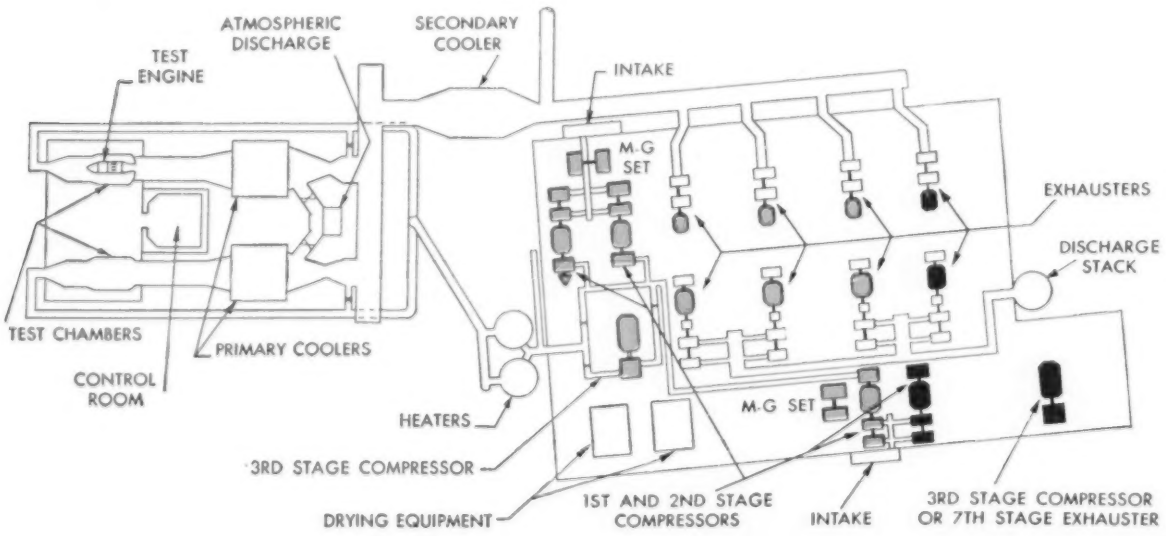
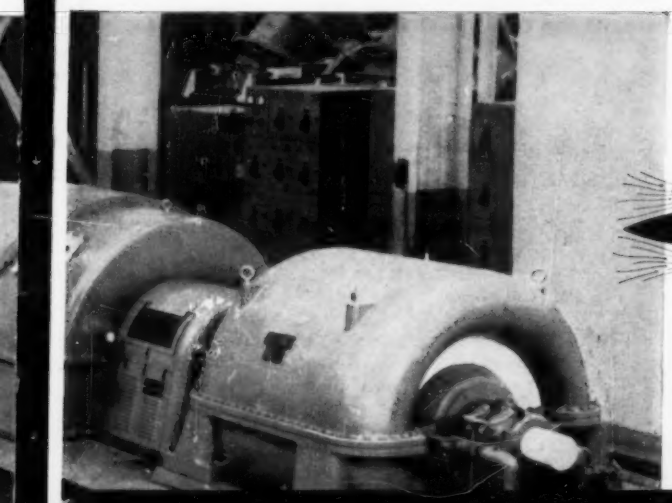
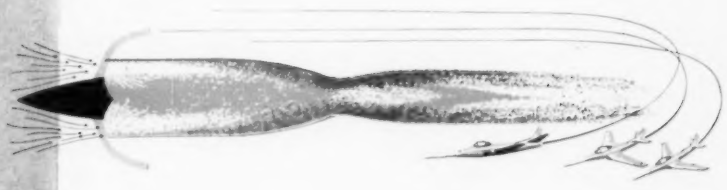
Each line of Elliott combustion air compressors (two are shown above) involves three casings. There are two first-stage casings with a total atmospheric inlet capacity of 106,000 cfm, discharging at 29.6 psia to the inlet of the second stage, which discharges at 60 psia. Unit at left shows, in the foreground, an Elliott radial in-flow expander. Behind the expander is the second-stage compressor, then the 16,500-hp, 3600-rpm synchronous motor, and beyond that are the two first-stage casings. In the background is the Elliott motor-generator set, a 5000-hp, 900-rpm wound-rotor induction motor driving a 4650-kva, 720-rpm alternator used for starting the synchronous motors.



In this layout of Propulsion Systems Laboratory, Elliott equipment already installed is indicated in orange. Elliott equipment on order and to be installed in the near future is indicated in solid black.





ELLIOTT COMPRESSORS AND MOTORS speed the nation's research at NACA's Lewis Flight Propulsion Laboratory

TO ACCELERATE important aircraft propulsion research, the National Advisory Committee for Aeronautics constructed the Lewis Flight Propulsion Laboratory in Cleveland. Testing facilities in the Propulsion Systems Laboratory at Lewis simulate jet engine speeds up to Mach 3 (three times the speed of sound at any given altitude) and altitudes above 60,000 ft.

To help create a wide range of in-flight conditions, important Elliott compressor and electric equipment has been installed. This includes Elliott combustion air compressors, and large 3600-rpm synchronous motors. In fact, to date the horsepower of Elliott motors installed and on order totals over 218,000, and the capacity of Elliott centrifugal compressors, over 359,000 cfm.

For information on how Elliott quality products can help you, call the nearby Elliott District Office, or write Elliott Company, Jeannette, Pa.

One of a line of three Elliott 10,000-hp, 3600-rpm synchronous motors which drive the second- and third-stage exhausters.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS
CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Q7-2

For more data circle 501 on Post Card

Hall Industrial Water Report

VOLUME 62 JANUARY 1958 NUMBER 1

By No Stretch of the Imagination

—can one think of getting along in the rubber industry without lots of water. And all the water used for generating steam, cooling, or general service must be conditioned to avoid problems such as deposit formation and corrosion. Undisciplined water can increase costs, hamper production and even shut down the plant. Contaminated waste water must also be cleaned up for disposal.

Hall Engineers are presently working with more than 80 plants in the rubber industry to avoid problems related to water. Whatever your industry, they can help you, too, with their special training and experience in the treatment of boiler water, cooling water, service water and process and waste water.

Careful Control Pays Off

In 1950 Hall staff engineer Len Highley set up the water conditioning procedures for two new boilers to provide steam at 550 psig in an eastern tire plant. Since then operation has been uneventful except for a short period of difficulty with hot-process softener filters and a temporary scare due to soap contamination of condensate. Because of these two events the boilers were acid washed as a precautionary measure early in 1956.

A recent report to Highley reads "We are sorry you were not able to get down to go over our No. 1 boiler, but we thought you would like to know that it was in the same clean condition as No. 2 which you inspected. Our operating people were very pleased and they have noted nothing to cause any concern or question."

This case might be considered just a routine report if we did not "look behind the scenes." There we find the close cooperation between the Hall engineer who prescribes water treating procedures on the basis of his study of the plant and the plant operating men who faithfully and carefully do the important job of maintaining day by day the water conditions which spell success.

Quick Diagnosis

When he collected a sample of the effluent from the hot lime-soda softener at a western tire plant, Hall Engineer John Henricks was surprised to find a noticeable amount of suspended matter in the water. This was unusual because, even though the softened water was not filtered, it had always been remarkably free from precipitated hardness which settled out in the sedimentation tank.

Investigation promptly disclosed that numerous new tire machines had boosted the load on the boilers and softener beyond rated capacities. The increased flow rate had to be maintained, but something had to be done to clean up the treated water to avoid increased chemical consumption in the boilers and abnormal sludge concentration in the boiler water.

Reasoning that a denser and deeper sludge blanket was needed in the softener tank to "filter" the suspended matter from the treated water, Henricks recommended reducing the blow-off from the tank and raising the level of the sludge blanket 6 to 12 inches. With these changes made, the softener water again was clear. But now there was another problem. The hardness of the water was running 0.5 gpg higher than normal. Henricks traced this to inaccurate weighing of treating chemicals and adjustment of slurry level in softener chemical tanks. With careful weighing of chemicals and preparation of slurry, hardness of the treated water ran consistently low at 0.2 to 0.3 gpg.

This is a case where the experience and training of the Hall Engineer enabled him quickly not only to spot trouble in the making but to diagnose the problems and solve them before they caused real trouble.

How to Fool a Deaerator

On his first service visit to a rubber reclaiming plant the Hall field engineer found an arrangement which topped all of his unusual experiences. Chemicals for the low-pressure boiler were fed continuously from two pressure pots with cold zeolite-treated water. The effluent from one pot entered the makeup water line to the deaerator downstream from the flow control valve. The effluent from the other entered the boiler feed line dowrstream from the deaerator.

Approximately 2000 gpd of water passed through each feeder. At low loads, when no makeup water was required, the cold water flowing into the deaerator from both feeders merely overflowed to the sewer. This also upset heater operation so when the load picked up undeaerated water was pumped to the boiler. The cold, undeaerated makeup water flowing into the boiler feed line continuously introduced dissolved oxygen into the boiler. Finally, at relatively low loads condensate entering the deaerating heater overflowed to the sewer.

By making a few simple piping changes so one feeder could be used intermittently to feed all chemicals, the Hall engineer was able to reduce makeup water consumption from 6000 gpd to 2000 gpd, to cut chemical feed by 75% and to insure satisfactory deaerator operation.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

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HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
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Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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NBP EPA

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

IN ONE of the last major addresses before his retirement as 1957 president of ASME, William F. Ryan said that an organization chart of the engineering profession "would be a good organization chart for a rabbit warren inhabited exclusively by two-headed rabbits." He added that, by contrast, an organization chart of the medical profession is "so logical and efficient that one would suppose that it had been designed by engineers."

To help correct the situation, Dr. Ryan urged support of a comprehensive detailed survey of the engineering profession as proposed by Engineers Joint Council and Engineers Council for Professional Development. A present appropriation by several engineering societies of $50,000 would scratch the surface of such a survey, Dr. Ryan said, but more time and money would be needed to complete it.

Among difficulties which have plagued engineers during the past few years, Ryan says, are lack of group consciousness and of an accepted code of ethics, confused state registration laws, lack of genuine legal status.

BRAVOS AND HONORS to: Donald A. Quarles, deputy secretary of defense, picked as 1957 recipient of the American Institute of Consulting Engineers' Award of Merit;

Robert L. Bartlett and Heinrich Hegetschweiler of GE, given the Prime Movers Committee award of ASME for their paper, Predicting Performances of Large Steam Turbine-Generator Units for Central Stations;

E. I. Pollard, chief electrical engineer of the Elliott Co, named chairman of the AIEE's Power Division Committee;

Garvin H. Dyer, director of the Missouri Water Co and manager and chief engineer of the Independence Division of the firm, elected president of the National Society of Professional Engineers;

John Blizard, director of research for the Foster-Wheeler Corp, given the 1957 Percy Nicholls Award of ASME and American Institute of Mining, Metallurgical and Petroleum Engineers, for achievement in the field of solid fuels;

Five distinguished engineers, elected as Fellows of the American Society of Mechanical Engineers. They are Edward H. Barry, mechanical engineer, Stone & Webster Engineering Corp; Ray N. Benjamin, vice-president and chief engineer, Georgia Power Co; Carey H. Brown, former superintendent of engineering and maintenance, Eastman Kodak Co; George H. Muschamp, vice-president in charge of engineering, Minneapolis-Honeywell Regulator Co; Thomas F. Parkinson, manager of transportation, General Electric Co.

DID YOU KNOW THAT: nearly seven per cent, or 142,000 persons, of a total of 2,000,000 Federal employees in 1953–54 were engaged in research and development, and about 37,000 were scientists and engineers.

Shipments of finished steel products during the first eight months of 1957 totaled a record of 56,392,714 net tons.

February 9–15, 1958, has been designated as National Electrical Week, and a promotional guide and kit is available at $1 from the National Electrical Week Committee, 290 Madison Ave., New York 17.

The atomic industry will stage its major 1958 trade show next March 17–21 at the International Amphitheatre in Chicago, and will feature progress in the industrialization of the atom.

ASPECTS OF underground power plant design are currently live issues in both Japan and Italy. The Sudagai project, built by the Tokyo Electric Power Co in 1952–55, is Japan's first complete underground power plant. Intensive investigations of seismic forces were conducted as part of the job, led the Japanese to realize the importance of geological conditions on the cost

of underground power plant structure.

In Italy, experience from the second world war has emphasized the desirability of power stations built underground as a defense against attack. Today there are reportedly 37 completely underground stations of at least 10,000 kw capacity each. Eight more are under construction and by 1960 it is expected that the capacity installed underground in Italy will reach about 4,500,000 kw.

NORMAN HILBERRY, director of Argonne National Laboratory near Chicago, made quotable quotes when he said recently:

"Our goal is to learn how to build uranium, or thorium, or plutonium-fuel plants which can be fitted into an electric system on the same economic basis on which you now add a new coal-fired plant.

"We are a long way from that goal. If you ask me how long, I would say, with many hedges, a decade.

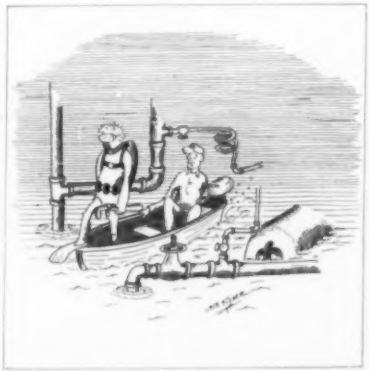
"We will eventually arrive at the goal of 25-cent heat — in units of millions of Btu's — from nuclear reactors in the United States, but we will first have to try out probably a dozen types of reactors, then carry the more promising of these to a second stage of development."

HARVARD UNIVERSITY and MIT have started work on the construction of a six billion electron volt accelerator. This is a synchrotron which will produce the fastest nuclear particles yet achieved by man. The machine will accelerate electrons to very nearly the speed of light, will uncover knowledge about the forces which hold nuclei together. It will take two years to build the accelerator. Initial operation is scheduled for January, 1960. The accelerator will be operated jointly by the two universities.

AN ELECTRICAL revolution in agriculture is predicted by scientists at Battelle Memorial Institute. Currently the average farm worker uses only 2500 kwh annually as compared with the 20,000 kwh used by the average worker in industry. For the future, the Battelle experts see farm use of electricity stepped up by many new practices. Among them: mobile generators and electrically driven equipment in the field; air conditioning equipment in barns and poultry houses; seeds treated with low-frequency electrical discharge to speed up germination; extensive electric lighting of field crops to influence plant maturation.

WORLD'S FIRST clock perpetually powered by the energy of the sun has been presented to the city of Palm Springs, Calif., by Hoffman Electronics Corp. It's to be seen in a glass case near the front entrance of the city's new Chamber of Commerce building. Some 20 silicon solar cells which are placed around the face of the clock convert the light energy given off by the sun into usable electricity to power the clock. Storage batteries, charged by the solar cells, store the electricity to operate the clock at night.

ULTRASONIC sound waves are now being projected through water to probe for invisible flaws in welded pressure tubing as the tubing is made. High frequency sound beamed into the metal under test is echoed back by any defect in the material. Ultimately the defect shows up as a "pip" on a screen known as an oscilloscope. Skilled operators can locate the defect precisely by referring to the point at which the sound entered the metal. Babcock & Wilcox Co has put this immersed ultrasonic inspection system to work as a quality control measure for electric resistance welded carbon steel tubing.



"The river valve is just to the left of No. 3 main condenser, and be sure you turn it clockwise this time!"

CHIMES ring out when something's out of tune in Power Plant 3 of Dow Chemical Co's Texas Division. A sign lights up on an annunciator panel near the chimes, and indicates to the operator where the trouble can be located. The necessary adjustment is made on one of the controls, the operator turns off the chimes, and all is well. Dow recently substituted the chimes for the loud industrial horns used for the same purpose. Result: the operator is more inclined to look for the trouble first, and the sound of the chimes doesn't get on his nerves while he's finding out what's wrong.

SOUTH'S largest turbine-generator, rated at 325,000 kva, has been ordered from the Westinghouse Electric Corp by the Houston Lighting and Power Co, it was announced recently.

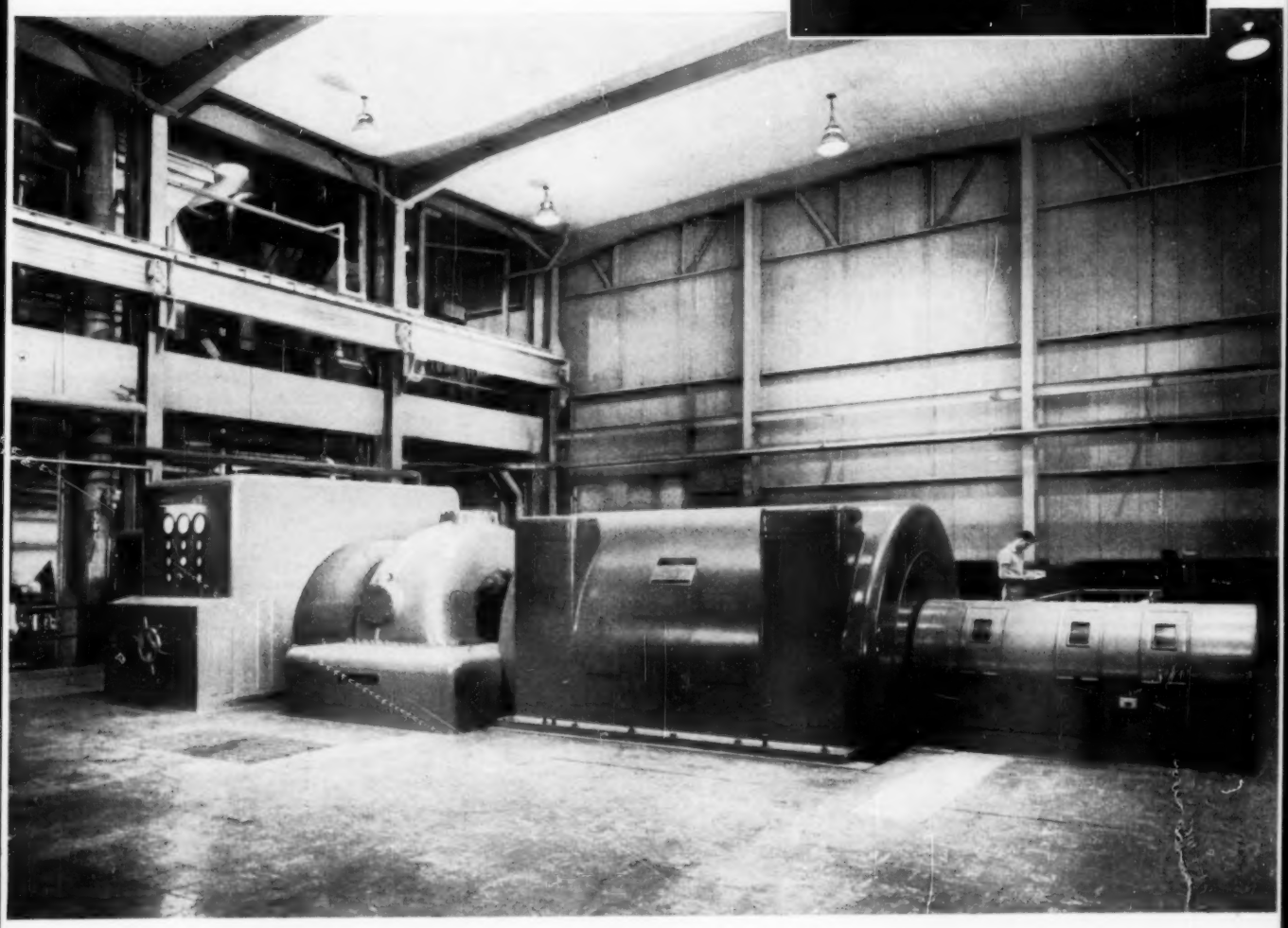
Scheduled for operation in 1961, this giant unit will equip a new power station at Smithers Lake near Houston and increase the company's electric power output by 11 per cent. It will be a tandem-compound, triple-flow turbine generator operating at 3600 rpm. Ebasco Services, Inc, will design and construct the outdoor power station, which will be similar to many of the utility company's other unhoused plants, such as the Sam Bertron Station.

ATOMIC LAMPS called Isolites have put in an appearance, from United States Radium Corp. They give power-free, interrupted illumination for periods up to 10 years, and are designed for a variety of signal and marking applications. Basis of the design is radioactive Krypton^{85} gas which excites specially processed phosphor crystals to luminescence.

NEW BOOKLETS you ought to have are: Steel Tubular Products, a new section of American Iron and Steel Institute's Steel Products Manual, available from the Institute at 150 E 42nd St, New York 17, N. Y.; and Guide Specifications for Typical Low-Pressure Commercial Heating Plant, 20,000 EDR (steam)-4,800,000 Btu per hr, from Bituminous Coal Institute, Southern Bldg, 15th and H Streets, NW, Washington 5, D. C.

DE LAVAL
TURBINE GENERATOR

Henderson, Ky., selects a third



In 1950,...
two De Laval 5,000 kw multi-stage turbine generators were installed in the central station of Henderson, Kentucky. These units operated so dependably that the City of Henderson ordered a new, larger De Laval turbine generator to meet their increased power requirements.

Put on the line in 1956,...
this 12,650 kw De Laval machine is an AIEE-ASME Preferred Standard Unit. It operates at 600 psig and 825F; the turbine speed is 3,600 rpm.

De Laval multi-stage turbines are rugged in construction, economical to run. Transmission of power may be either direct or through speed reducing gears. De Laval multi-stage steam turbines are available for all services, including operation at the high pressures, high temperatures employed in steam plants of the latest design. Units are built in sizes up to 25,000 hp.

DE LAVAL *Turbine Generators*

DE LAVAL STEAM TURBINE COMPANY
816 Nottingham Way, Trenton 2, New Jersey

WHAT THEY TELL US

▶ **AIRCON** converts keep popping up. Aircon, for those who are just getting in on this, is the new term which Reader R. M. Francis has proposed be adopted for air conditioning (see this department in the September and November issues, 1957). This note has come from Lucien R. Greif, of Greif-Associates, engineering and industrial publicists:

> We're all for it. Mr. Francis' idea is very sensible. We always did like short words better than long ones, and we hope from now on all manuscripts for POWER ENGINEERING will use "aircon, airconned, airconning." Somebody has to lead the parade. Might as well be POWER ENGINEERING.

▶ **R. C. ALEXANDER,** superintendent of the Valley Steam Plant in Sun Valley, Calif., touches on a theme close to our heart when he writes us:

> I appreciate receiving POWER ENGINEERING magazine and particularly like the editorial treatment, which considers that the readers are mature individuals.

Naturally, as editors, we are always more than pleased when a reader gets this impression, for it reflects exactly the attitude we have always taken toward the readers of POWER ENGINEERING, and which we want our contributing engineer-authors to take toward the readers.

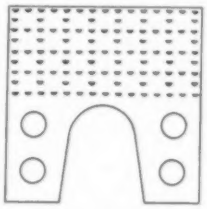
It is one thing to try to make things clear to readers by using methods of presentation and language as simple as possible, consistent with technical accuracy and the general use of language in the power engineering field. But it is quite another thing to present everything in a way that "writes down" to the reader.

It is the first objective that motivates our editorial style.

▶ **G. R. SETTERLUND'S** lively account of the problems he encountered when he moved in as chief of an old power plant (POWER ENGINEERING, September 1957, pages 55–57) has drawn interested queries from a number of readers. C. E. Mueller of the Diamond Power Specialty Corp in Lancaster, Ohio, wants to know what metal Setterlund found most satisfactory for reblading exhauster fans. To this Setterlund replies:

Although exhauster blades are certainly standing up better now than previously, I do not feel that we have tested enough kinds of metals to make an honest comparison. "Drumco" steel increased the useful life considerably. In one case T1 steel, also from Drummond McColl Steel, proved better than Drumco; in another case, about equal.

Facing the blades with hard surfacing rods has proved even better. Colmonoy rods, Coast Metal rods, etc., have been used as solid facings. Colmonoy paste fused with carbon rods equalled either of the above solid facings, and the blade was reusable after refacing again. I have a feeling that cross-hatching with hard metal rods will prove most economical and lasting. Put a bead around perimeter of the blade and then pattern beads at about ¾-in. squares



over the wearing surface (see sketch). This can be done on the most economical steel plate available.

On previous occasions, when we have asked engineers about reblading or rehabilitating blades on exhauster fans, we have been told that one of the best materials is common ordinary floor plate, properly shaped and bolted or, preferably, welded on.

▶ **ANOTHER QUERY** to Setterlund comes from H. H. Reisman of Deere & Co in Moline, Ill. Reisman asks about the type of refractory used for lining the induced draft fans. (Setterlund had indicated that the fans were lined with metal lath and refractory.) Amplifying his description, Setterlund says that it was an article on how insulating cement cures casing erosion on ID fan (POWER ENGINEERING, March, 1955, page 69) that actually stimulated his trial. He writes:

> The R & I Super No. 3000 is available through Refractory and Insulation Corp.
>
> The lath must be cut to fit the contours of the casing. Instead of using fasteners, simply tack weld in convenient patterns, placing tack spots at about 5-in. to 6-in. centers. Apply the first coat thick enough to just cover the lath. Be sure to trowel it well in against the casing.
>
> We used an electric heating element and a fan to circulate hot air through the casing. One fan was not heated in this manner and a blister developed after boiler start-up.
>
> After the first layer is quite dry, probably within 16 hours, or less if higher heat is used, smooth trowel a finish coat of the same material over the entire rough surface. This finish coat will probably average ¾-in. to ⅝-in. thickness. We filleted in all edges and feathered around inspection doors, etc.
>
> I might add that we fill all lining joints in exhausters, elbows and bends in pulverized coal lines from mill to furnace, and are seriously thinking of lining one exhauster case completely in lieu of present cast liners.

▶ **UNUSUAL** request reached this department the other day from Paris, France. Institut Français des Combustibles et de L'Énergie wanted to get hold of a copy of an article on sodium pentachlorophenate treatment for cooling water, written by Max Gelfand for the May 1941 issue of this magazine. We promptly dispatched verifax copies of the article. Now just as promptly comes back a note from H. Perdon:

> Les deux photocopies que vous nous avez envoyées nous sont bien parvenues. Nous vous remercions d'avoir bien voulu nous addresser ces documents gracieusement et aussi rapidement. Le texte nous suffit sans les photos.
>
> En vous renouvelant nos remerciements, veuillez croire, Messieurs, à l'expression de nos sentiments distingués.

▶ **HOW TO SET UP** operation of a new power plant, a series of articles by Paul N. Garay, which began in the September issue, is finding its way with POWER ENGINEERING readers. Jack E. Webber, assistant superintendent of the utilities department of U. S. Steel's Fairless Works in Pennsylvania, writes:

> I would like to take advantage of your suggestion to obtain tear sheets and save the articles by Paul Garay. I would appreciate your forwarding about 12 copies of the article in the September issue and if possible continue to do that for the remainder of the articles that will be published. I am sure the articles will prove most helpful to us, and we appreciate your making them available.

The fifth and last article in the Garay series is scheduled for next month. Then we expect to make reprints of the set. Want copies?

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user. Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8101 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

801ST

ARMSTRONG STEAM TRAPS

How Different Condensing Rates Can Slow Production

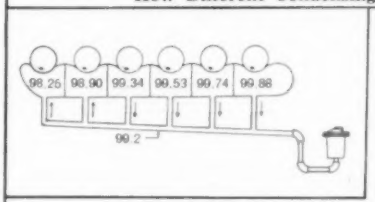


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

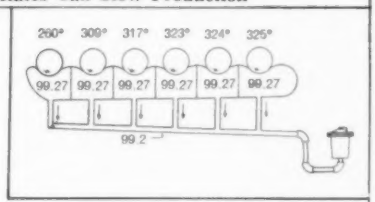


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

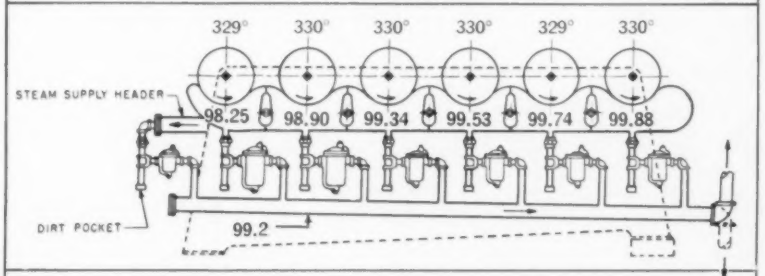
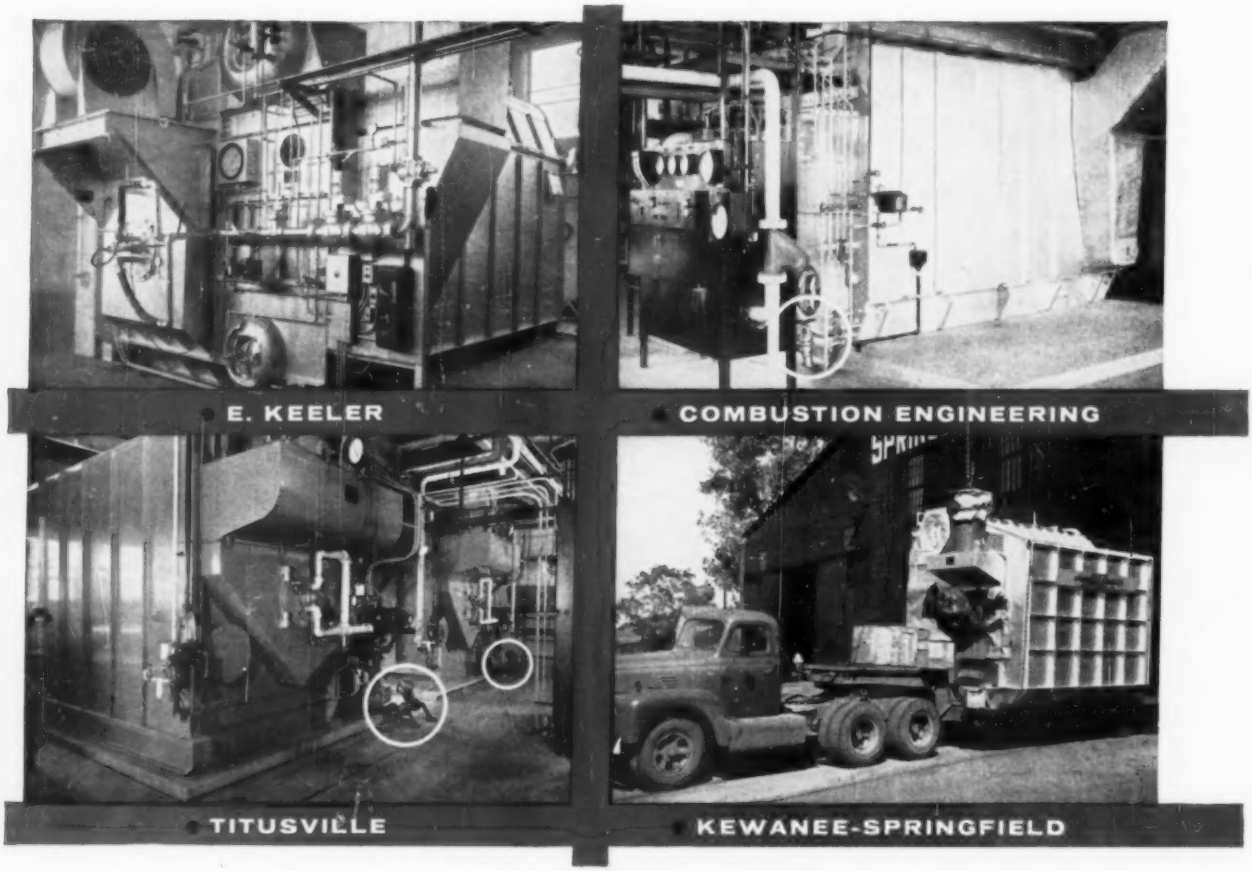


Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.

For more data circle 504 on Post Card

the blow-off valve trend on "package" boilers is

YARWAY SEATLESS



YARWAY® BLOW-OFF

■ More and more leading manufacturers of package-type boilers are featuring Yarway Blow-Off Valves on their units. Many are standardizing on Yarways.

The reason—good blow-off valves help good package boilers *perform better*.

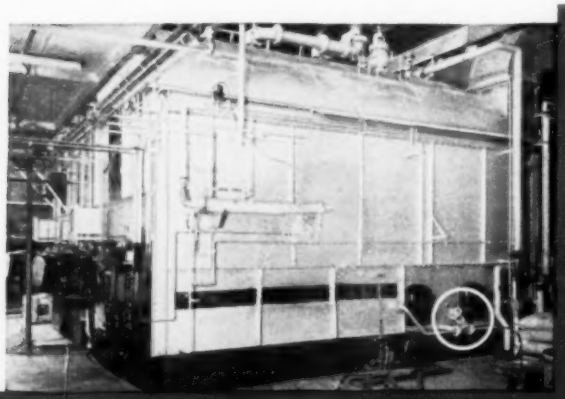
Yarway—known for nearly 50 years for *quality* blow-off valves—offers advanced design, dependable service, and reasonable cost . . . three features attractive to all boiler users.

The Yarway Seatless Blow-Off Valve, with balanced hollow sliding plunger and no seat to score, wear, clog or leak, is the most widely used valve for low and medium pressures.

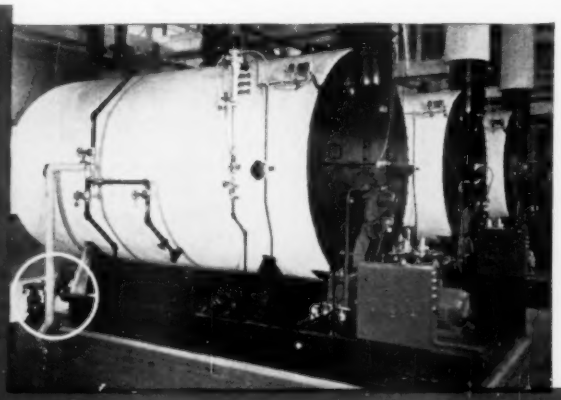
Specify Yarway Seatless Blow-Off Valves on your package boilers. All boiler makers will supply them.

For full description of Yarway Seatless Blow-Off Valves write for Yarway Bulletin B-426.

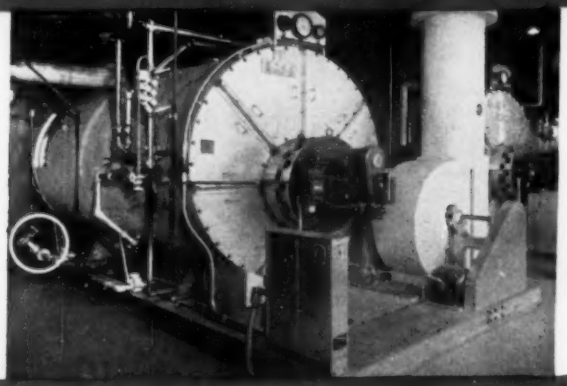
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



● ERIE CITY



● CLEAVER-BROOKS



● PREFERRED UTILITIES

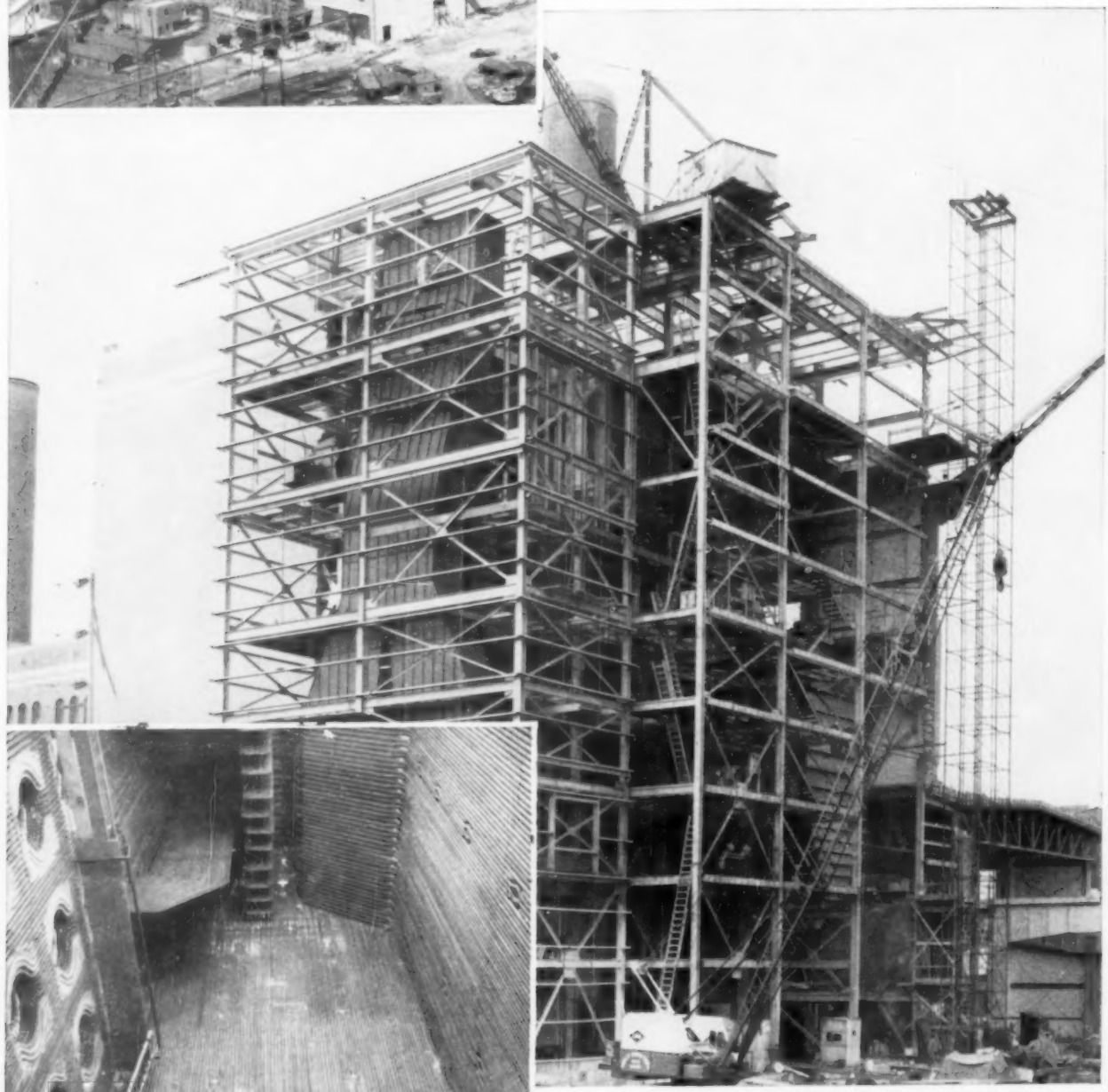
● **Yarway Seatless Tandem Blow-Off Valve** (angle-straightway combination) with angle valve sectioned to show balanced sliding plunger design.

● **Yarway Seatless Tandem Blow-Off Valve,** angle-angle combination, straightway-angle or straightway-straightway tandems also available.

VALVES

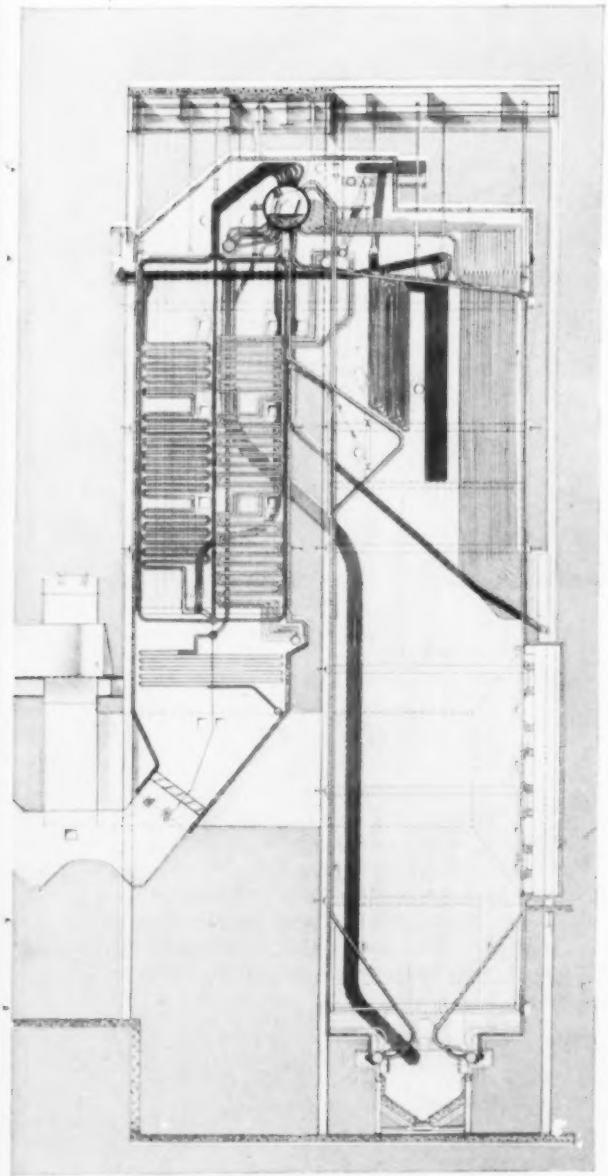
For more data circle 505 on Post Card

This is R. S. Wallace Station showing modern enclosure for Unit No. 6, a 600,000 lbs./hr. Riley Boiler. Below, Unit No. 7 under construction.



Inside furnace of Unit #7 at E. Peoria. At left — 5 of 16 Riley Flare Type Burners; burner openings are water-cooled. Top left — one of two bare tube platens that are employed to evenly distribute furnace heat across superheater and reheater.

Sixth RILEY Boiler at R. S. Wallace Station



Capacity — 690,000 lbs/hr.
Drum pressure — 1650 psig
Superheat, Reheat — 1000 F
Fuel: Central Illinois Coal
Average Overall Efficiency — 87.7%
COMMONWEALTH ASSOCIATES, INC.
CONSULTING ENGINEERS

CENTRAL ILLINOIS LIGHT COMPANY has also ordered its EIGHTH Riley Boiler for its Lamarsh Station

Since 1939, Central Illinois Light Company has installed six Riley Boilers in its East Peoria R. S. Wallace Station. The latest, a 690,000 lb/hr Reheat Unit is illustrated here and will shortly go on the line. The recent order of an 850,000 lb/hr Reheat Unit for Lamarsh Station will bring the total of steam generated by Riley boilers to 3,415,000 lbs/hr. Dependable operation, and high availability are the operating characteristics of these Riley boilers.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs. .

RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Sales Offices: Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

For more data circle 506 on Post Card

For Fly Ash Collection...

Western Precipitation
presents
its latest development
in a quarter-century of
continuous advancement
in Mechanical Collectors

...The "9VGR" MULTICLONE!

Over 25 years ago

Western Precipitation Corporation pioneered the high-efficiency multiple-tube principle that has proven so superior it is now the pattern for the industry.

The Multiclone continues to be years ahead of all other centrifugal collectors because it incorporates the invaluable "know-how" gained through these many years of leadership in the field —leadership that is further emphasized by introduction of the 9VGR Multiclone, another important milestone in Multiclone's quarter-century of outstanding performance.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

NEW 9VGR FEATURES...

1. *No need for continuous external support.*
2. *Easier and less costly to insulate.*
3. *Minimum dust stratification.*
4. *Improved dust distribution to all tubes.*
5. *Simpler installation, lower erection costs.*
6. *Freedom from leakage at all critical points so that full collection efficiency is obtained.*

Plus **The proven superiority of CAST IRON TUBES and VANES!**

Through the years, others have tried special alloy steels and so-called "miracle" metals, but nothing has proven as satisfactory *in actual field service* as cast iron. In the past quarter-century more than 270,000 Multiclone tubes have been placed in service with less than 1.85% replacement—*a performance record unequalled in the industry!*

There are many other advantages built into the 9VGR. There is a Multiclone representative near you who will be glad to supply complete details. Or write direct, asking for your free copy of Bulletin #M209 which contains full details.

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases ... and Equipment for the Process Industries

Main Offices: **1029 WEST NINTH STREET, LOS ANGELES 54, CALIFORNIA**

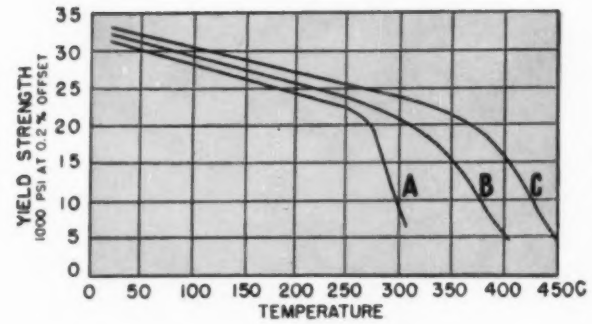
Chrysler Building, New York 17 • 1 North La Salle Street Building, Chicago 2 • Oliver Building, Pittsburgh 22 • 3252 Peachtree Road N. E., Atlanta 5 • Hobart Building, San Francisco 4

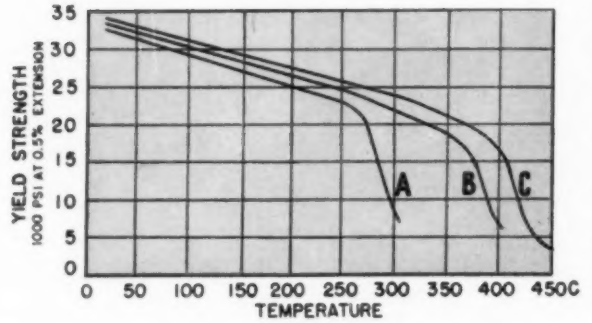
Precipitation Company of Canada Ltd., Dominion Square Building, Montreal

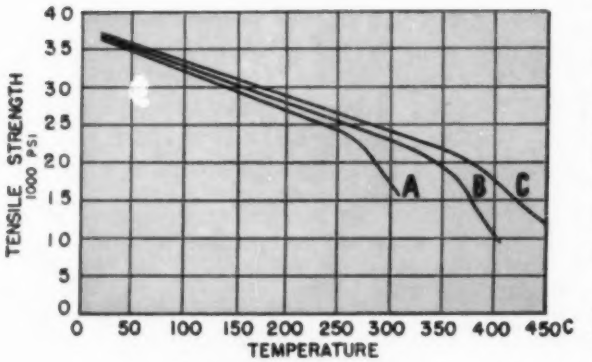
Representatives in all principal cities

For more data circle 507 on Post Card

How to give electrical conductors an improved margin of safety at elevated temperatures







A. Silver content normal
B. Silver 8.7 ounces per ton
C. Silver 28. ounces per ton

Copper strips cold rolled,	0.050 ins. gage
Time to heat, approximately	1¼ hours
Time of test at heat, approximately	¼ hour
Speed, testing machine head,	0.01 ins. per min.

American Brass Company Metallurgical Research Laboratory 1954

Tests show influence of silver on tensile properties of high-conductivity copper at elevated temperatures

Silver-bearing copper is used extensively in windings, collector rings, and commutators of motors and generators, in order to retain structural strength at elevated temperatures during assembly and operation.

There are now many other places where electrical conductors must stand up under temperatures well above those heretofore considered normal.

The amount of silver needed to meet a particular set of conditions, however, has until recently been difficult to determine. At the left are charts summarizing the results of tests made in The American Brass Company Metallurgical Research Laboratory, which can help serve as a more precise guide.

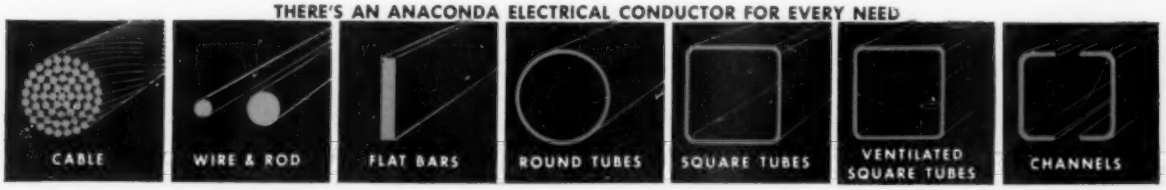
The curves for the yield strengths at 0.2 per cent offset and 0.5 per cent extension are significant to electrical engineers with problems involving the operation of conductors at elevated temperatures, for these values are indices of the limits of elastic behavior. The drop in absolute values of the tensile properties of all three coppers with rising temperature, however, should be noted and be allowed for in the selection of shape and size of conductors that are expected to run hot.

For more complete information on the effect of temperature on the mechanical and electrical properties of copper, send for a copy of Publication C-25, "Anaconda Copper for Electrical Conductors." This 62-page book also has a wealth of other general information, plus convenient new tables to help you in the selection of rigid bus conductors.

Technical Service. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance—or to get a copy of "Anaconda Copper for Electrical Conductors"—see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 57101

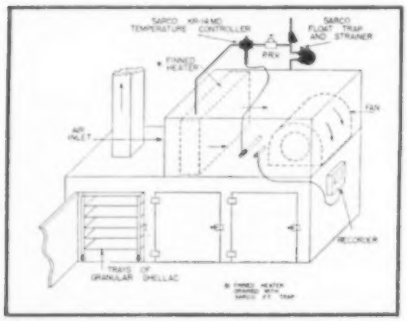
ANACONDA®
COPPER CONDUCTORS
Made by The American Brass Company

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED

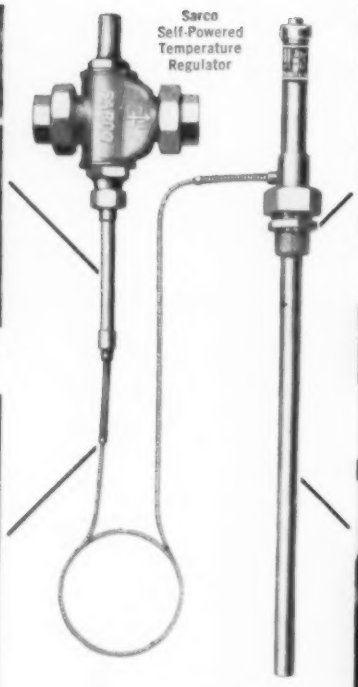


For more data circle 508 on Post Card

Water storage tanks — Sarco self-powered temperature controls on service water storage tanks from twin heaters.

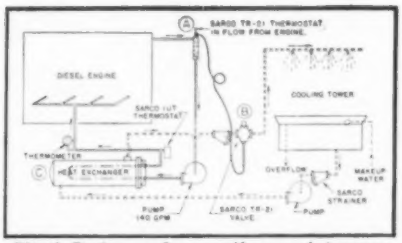


Shellac dryer — even temperature maintained; moisture uniformity of granular shellac accurately controlled — by Sarco self-powered temperature control.



Sarco Self-Powered Temperature Regulator

FOR YOUR INDUSTRY
Chemical Processing • Metalworking
Food • Textile • Paper
Oil Refining • Others



Diesel Engine — Sarco self-powered temperature controller used on diesel engine cooling system. Also ideal for compressors.

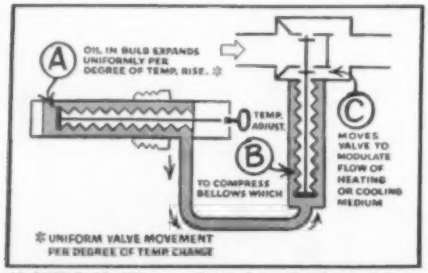
Steam-jacketed kettle — desired temperature of kettle content is automatically maintained by Sarco self-powered temperature control. Steam waste, uncertainty of manual control eliminated.

How to get Automatic Temp. Control that's simple, dependable, inexpensive

HERE'S the way to get rid of uncertain, time-wasting manual temperature control . . . *throughout* your plant. And without investing in complicated, costly temperature control equipment.

These SELF-POWERED Sarco controls are inexpensive, simple, dependable, accurate. They can be used for 85% of your jobs. ½" size costs only about $100!

Thousands of these Sarco controls are giving dependable, accurate service for firms such as Colgate-Palmolive Co., Sinclair Refining Co., Swift and Co.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE. ✲
TEMP. ADJUST.
B
TO COMPRESS BELLOWS WHICH
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
✲ UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP CHANGE

AS SIMPLE AS ABC . . . that's Sarco Self-Powered Temperature Control. A thermostat with capillary tubing and a valve . . . that's all there is to it!

SARCO SELF-POWERED TEMPERATURE CONTROLLERS
—need no power source

1. Self-Powered — no compressed air or electricity needed.
2. Easy to install — by any pipe-fitter.
3. Self-contained — no exposed mechanism. Packless valve.
4. Simple — no gadgets that take a technician to read and repair.
5. Not affected by cross-ambient temperatures or elevation of the bulb.

Send for Bulletins: No. 620 — Self-powered Temperature Controls. No. 710 — Self-powered Cooling Controls. No. 1025 — Electric Indicating Temperature Controls. Sarco Company, Inc., 635 Madison Avenue, New York 22, N. Y. **2208-B**

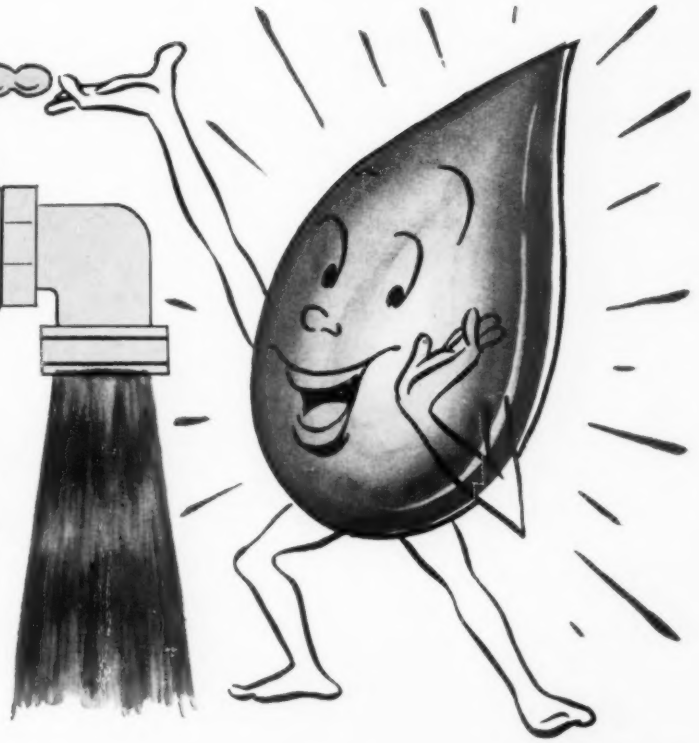
SARCO
Automatic Temperature Control

ELECTRIC INDICATING AND SELF-POWERED TEMPERATURE CONTROLLERS • STEAM TRAPS • STRAINERS

For more data circle 509 on Post Card

ALLIS-CHALMERS

Water Conditioning



Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

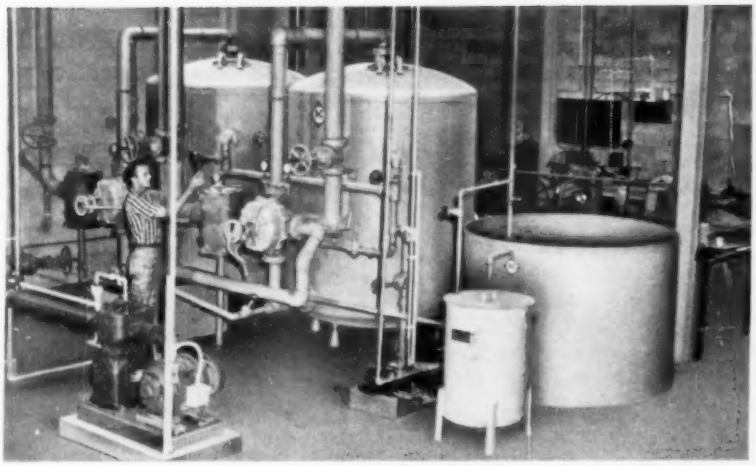
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

Get Details

For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS CHALMERS

A-5552

For more data circle 510 on Post Card

C-E BOILER "Makes a hit" AT NEW GLATFELTER PLANT

Consulting Engineer tells why . . .

After completion of Acceptance and Peak Load Tests on a C-E Vertical-Unit Boiler, Type VU-40, at the P. H. Glatfelter Company's new Spring Grove, Pennsylvania, paper mill, The H. M. Wilson Company, Consulting Engineers of Philadelphia, stated, "Now, having determined the results of the tests, we are happy to advise you that the overall performance of the boiler was excellent, and we feel that this particular boiler is of outstanding design and construction. We have previously commented on the excellent cooperation of your Engineering Department in the design and development of this boiler, and can only reach the conclusion that your entire organization has been most cooperative and has done a fine job."

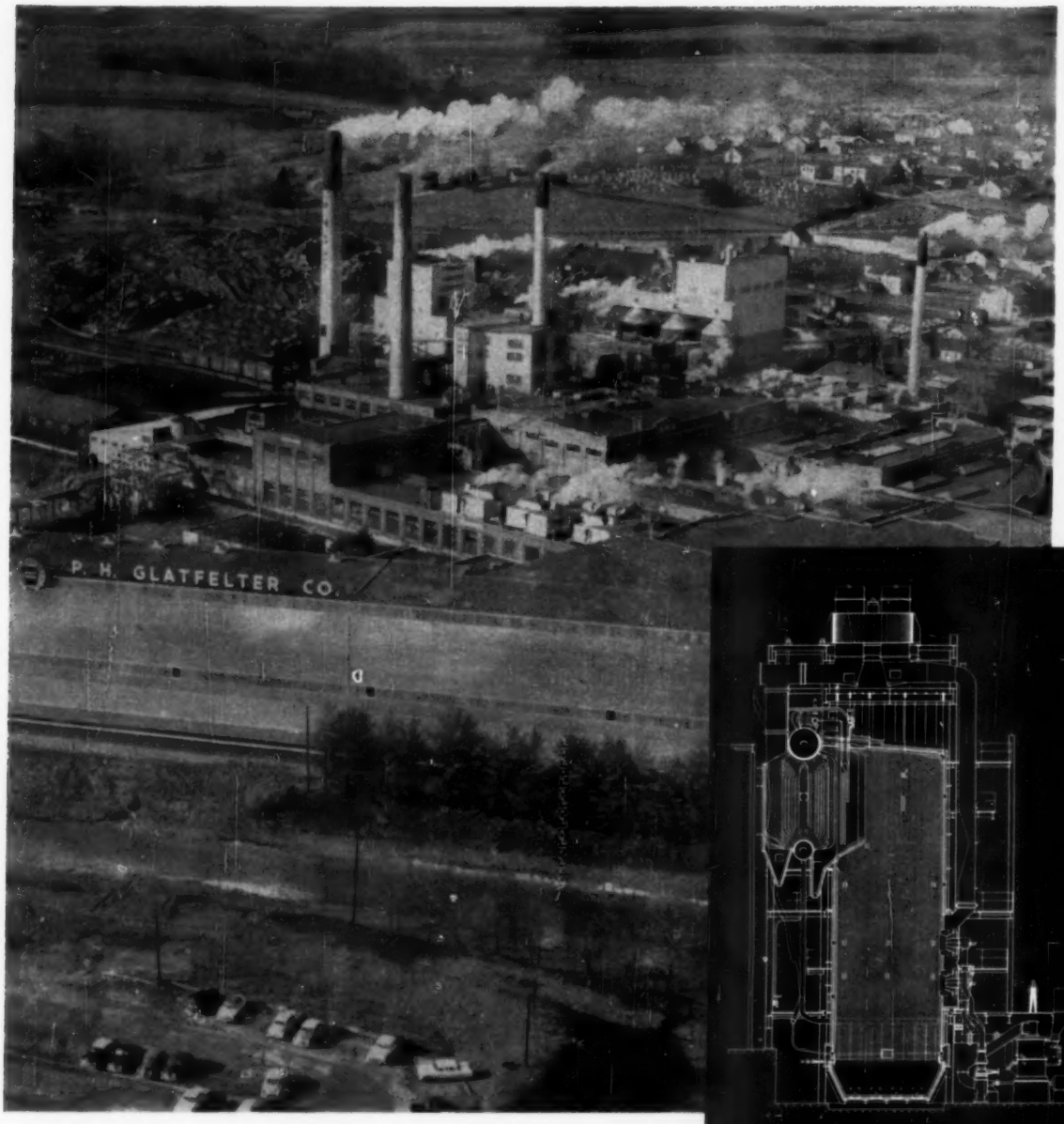
This opinion finds added significance in a statement by the company president, Mr. P. H. Glatfelter, III, who states, "We are well pleased with our choice of this C-E boiler for our new plant."

We, of course, are proud of this boiler, which, like the many other C-E installations of this and other types, is proving its superiority under actual operating conditions. When *you* need boilers, remember that Combustion Engineering has a complete line of steam generating and fuel burning equipment—a size and type that will meet your requirements exactly.

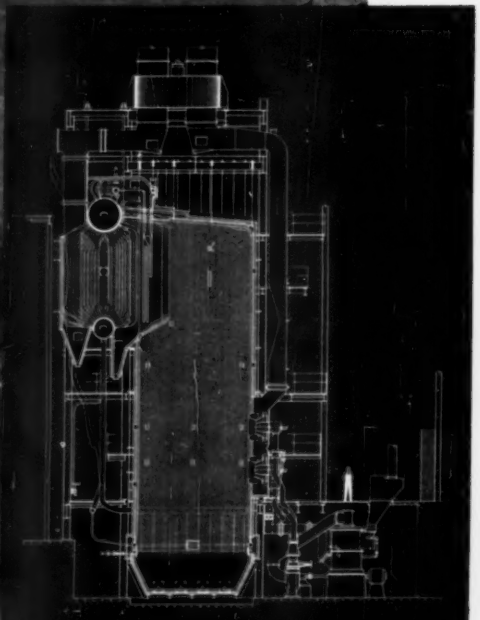
COMBUSTION

Combustion Engineering Building

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The recent start-up of this new paper mill marked the completion of the P. H. Glatfelter Company's largest expansion in its 93-year history. Included in this expansion was a new Fourdrinier paper machine, a 177-acre lake, and a C-E Vertical Unit Boiler. This new mill, which is in the best tradition of modern industrial architecture, has a potential capacity of over 300-tons daily.



Cross-sectional view of the C-E Vertical-Unit Boiler, Type VU-40S, installed at the Glatfelter Paper Mill in Spring Grove, Pa. This unit is designed to burn coal or oil, either separately or in combination, with full rated capacity obtainable from either fuel. It has a maximum continuous capacity of 250,000 pounds of steam per hour at 600 psi and 650°F.

ENGINEERING

C-138

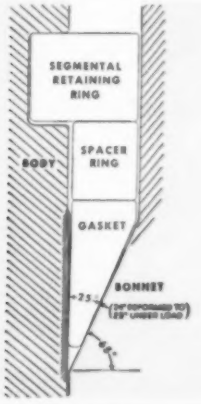
200 Madison Avenue, New York 16, N. Y.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 511 on Post Card

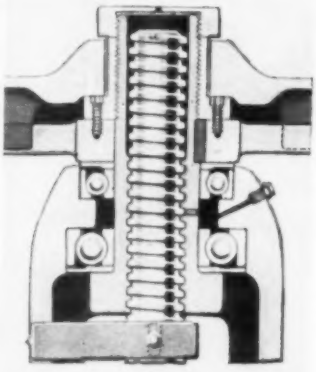
How To Get SPECIAL Features

Tips on selection, installation and operation of steel



NON-LEAK PRESSURE-SEAL BONNET JOINT

By changing bonnet-gasket angle from 45 degrees to shape shown, sealing area is increased 300%, sealing force doubled. Soft iron gasket is electroplated with a lead alloy which flows under pressure, assures tight seal. No sharp gasket edge to damage. Easily disassembled.

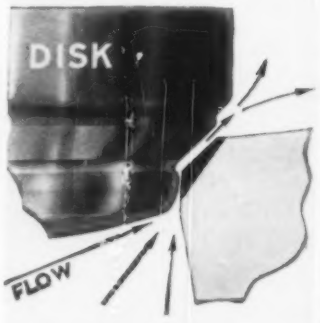


EVALTHRUST* BALL-BEARING CONSTRUCTION

This patented ball-bearing construction is found in all large, high-pressure Edward Valves. Double races on the yoke stem reduce operating torque . . . effectively transmit highest closing torques. An Edward "exclusive."

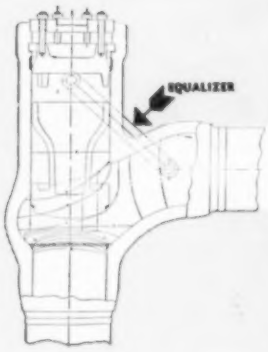
LEAK-PROOF INTEGRAL SEAT

Integral Stellite seat in Edward Valves cuts maintenance, prevents leakage between seat and body. For perfect alignment, applied Stellite is precision-machined in same set-up as body bore, then carefully lapped to form drop-tight mated seating surfaces.



ORIGINAL-DESIGN EDWARD EQUALIZER

For check and non-return valves, the Edward Equalizer connects the high-pressure area above disk-piston with the high-velocity, low-pressure area in the valve outlet. Increases disk lift, cuts pressure drop, reduces disk vibration.



EVALPAK* PREMIUM VALVE PACKING

Edward developed the *first* asbestos-graphite packing with special processing to prevent stem pitting. Die-molded to fit exactly the stem and stuffing box, it is wire-supported and features low operating torque. Durable, easily replaceable.

IMPACTOR* HANDWHEEL

Exclusive Impactor* handwheel multiplies the closing force a man can deliver, assures tight seating with minimum effort in minimum space. Often eliminates need for bulky, expensive gearing or motors.

*Reg. T.M., Edward Valves, Inc.

Rockwell-Built Edward Valves

in STANDARD Steel Valves

valves from Edward, long-time leader in the field

We all know that no one gets "something for nothing." Yet, by careful evaluation and selection, it *is* possible to obtain "special" features in *standard* steel valves. The secret lies in buying "by company" as well as by price. In dealing with Edward, whose products have been the industry's standard of excellence for years, you avail yourself of three important benefits:

1. access to the results of continuing laboratory research on steel valves;

2. expert assistance on valve selection, installation, operation, maintenance and repair;

3. steel valves which are truly superior in design, function and durability . . . but which are not substantially more expensive than ordinary types.

For example . . . a half-dozen "special valve" features —which are *standard* in Edward Valves—are shown in handy clip-out form on the opposite page. ALL of these features are Edward "firsts" . . . MOST are Edward "exclusives" . . . EACH means *extra value* for you!

We invite you to consult your Edward Valve Representative. He is technically trained, thoroughly experienced, eager to help you obtain the *most* value for your valve dollar. At his disposal—and yours—are the results of substantial investment in steel valve research. Let him *use* those results to solve your problems. A card or a call will bring him "on the double" . . . so make it a point to contact us *now!*

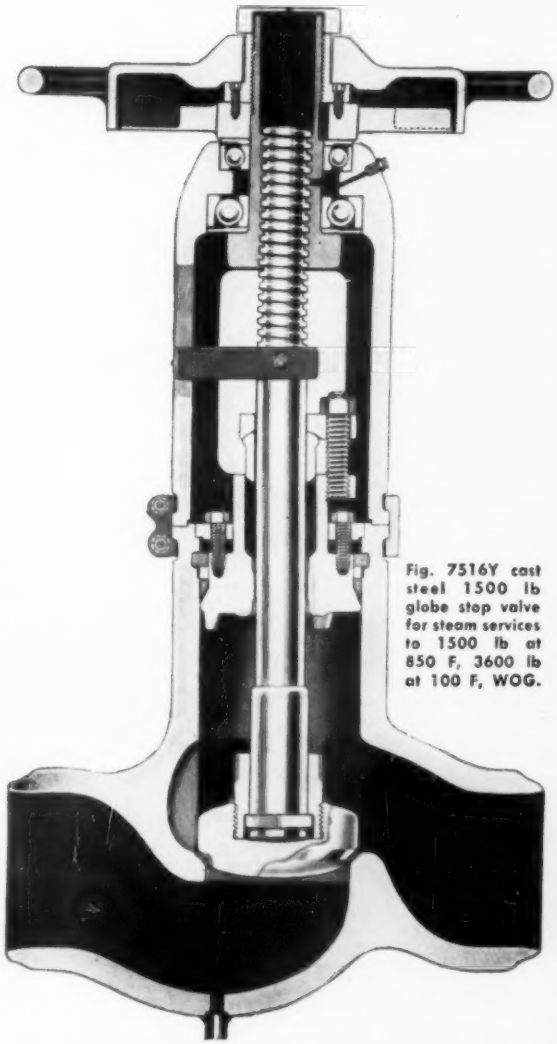


Fig. 7516Y cast steel 1500 lb globe stop valve for steam services to 1500 lb at 850 F, 3600 lb at 100 F, WOG.

Edward builds a complete line of forged and cast steel valves from ⅛" to 16" in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs for pressures up to 7500 lb with pressure-seal, bolted, union or welded bonnets and screwed, welding, or flanged ends.

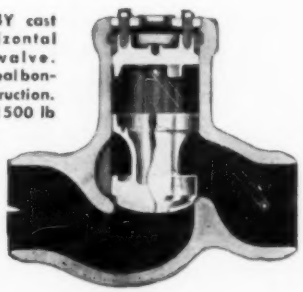


Fig. 7594Y cast steel horizontal check valve. Pressure-seal bonnet construction. Rated at 1500 lb at 850 F.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1202 West 145th Street, EAST CHICAGO, INDIANA

DECIDING ON AIRFOIL?

INSIST ON "BUFFALO"

Mechanical Efficiency up to a True 92%

MAXIMUM FORCED-DRAFT PERFORMANCE UNDER SPECIFIC CONDITIONS

WHEN YOU INSIST ON "BUFFALO" AIRFOIL FANS you immediately find many important factors in your favor. "Buffalo" Airfoils give you *true* mechanical efficiencies up to 92%. Main point here is that "Buffalo" Airfoil Fans will positively *live-up* to their ratings. They are designed, engineered, built and tested to deliver these peak efficiency ratings. You can *rely* on "Buffalo" Airfoils to meet your performance specifications.

There are sound engineering "reasons why" behind the proven performance of "Buffalo" Airfoil Fans. "Buffalo" offers unique, deep-blade airfoil design plus a brand new approach to streamlining. Turbulence is reduced to an absolute minimum because of the smooth inlet bell — the matching curved wheel flange — the new "Buffalo" divergent outlet. And with "Buffalo", you get more than an airfoil fan — you can choose from a *complete line* of airfoil and semi-airfoil wheels, to give you maximum efficiency for your precise operating conditions.

Whichever "Buffalo" Fan *you* select as best-suited to your operation . . . you're sure of getting the famous, rugged, dependable, long-lasting construction that's been an integral part of every "Buffalo" product for more than 80 years. We call it the "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

For the Finest in Mechanical Draft Service, Write Us now for Bulletins FD 106, FD 205, and F 200.

BUFFALO FORGE COMPANY
BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

For more data circle 513 on Post Card

Sure-Reading ...DIAMOND "Multi-Port" Bi-Color Gauge

for BOILER PRESSURES to 900 psig

MODEL MP-900

Ports Have Individual Round Glass, Mica and Gasket Instead of Long Strips
"Sealed Beam" Lamps in "Hi-Lite" Illuminator
STEAM SHOWS RED
WATER SHOWS GREEN
Complete Port Change and Cut Back into Service in Minutes Instead of Hours
Gauge Not Removed from Boiler for Gasket Changes and Other Normal Maintenance
End Stems Stainless Steel (Also Available with Flange Connections)

Also available is Model MP-3000 for boiler pressures to 3000 psig

The individual round ports each having its own round glass, round mica and round gasket (instead of the conventional long strips) means less stress and strain . . . resulting in greatly reduced maintenance. When replacement is required, it is usually only one port . . . which can be changed in a very few minutes . . . and without removing the gauge from the boiler.

The Diamond Bi-Color feature is another important advantage of the MP-900 Multi-Port . . . steam always shows red and water always shows green. There can be no question of the water level.

Recommended for both new and old boilers up to 900 psig, the MP-900 Multi-Port will give you a new standard of gauge operation. Use the coupon below for additional information.

7757

DIAMOND POWER SPECIALTY CORP. AB
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 2044 explaining the advantages of the Diamond MP-900 "MULTI-PORT" Bi-Color Gauge for all boiler operating pressures up to 900 psig.

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DIAMOND POWER SPECIALTY CORP.
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Diamond Specialty Limited • Windsor, Ontario

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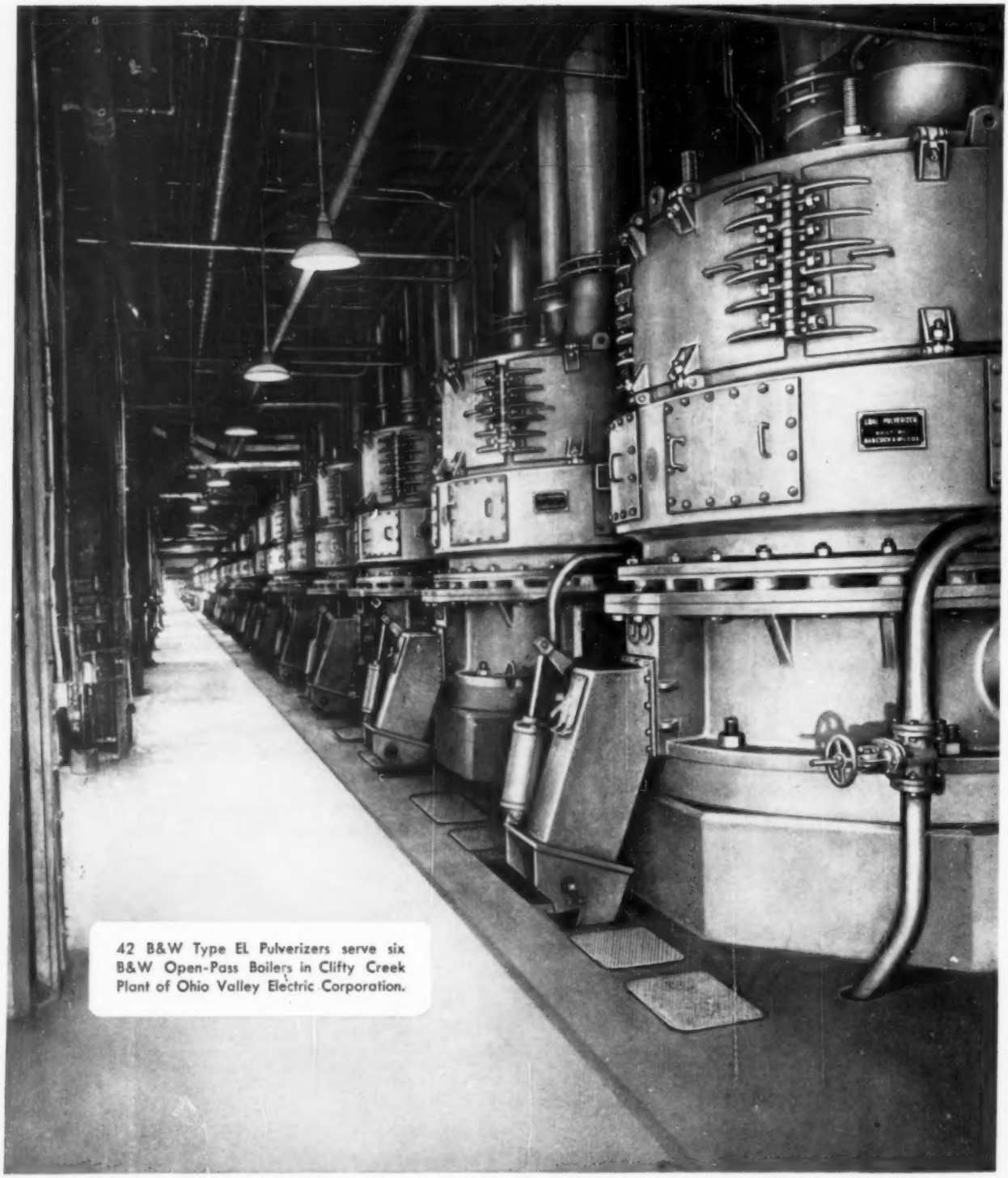
Have You Investigated

THE MODERN B&W



42 B&W Type EL Pulverizers serve six B&W Open-Pass Boilers in Clifty Creek Plant of Ohio Valley Electric Corporation.

DIRECT-FIRING SYSTEM?

A Compact, Space-Saving Package of Efficient Grinding Power

More power and capacity in a compact arrangement . . . long-range dependability . . . reduced operating cost — these are the measurable results of continuous, intensive development of the modern B&W Pulverizer. It has established an outstanding production and efficiency record in thousands of commercial installations. Here are some reasons why:

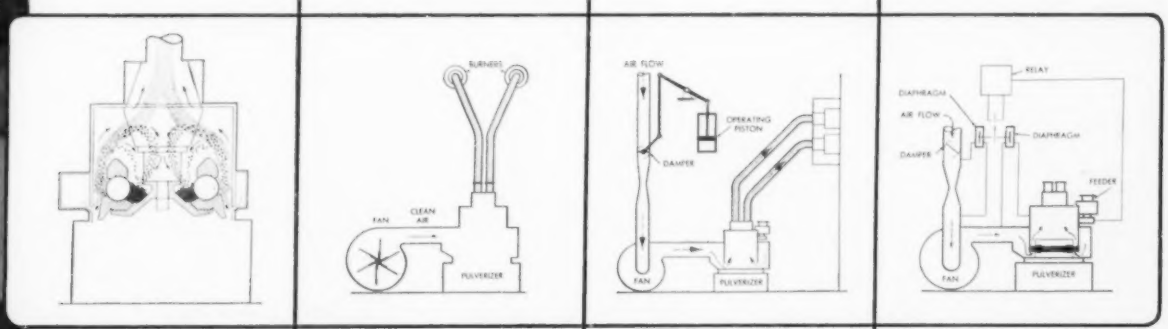
Continuous High Fineness Over Entire Service Life: Efficient combustion requires high fineness at all times. The high circulating load of the B&W Pulverizer permits efficient and dependable classification of product, so that only material of proper fineness leaves the unit. In addition, its slow-speed, spring-loaded ball bearing grinding elements maintain proper grinding contact throughout their service life.

Handles Wide Variety of Low Grade and Wet Coal: Regardless of the coal's grade or whether it's dry or soaking wet, the B&W Pulverizer's unique and exclusive recirculation of fuel through heated air assures efficient grinding . . . eliminates shutdown, capacity loss, or special attention from operators.

Simplicity of Arrangement and Reduced Maintenance: Accessibility for all normal maintenance makes it simple, quick, safe and low-cost. Adjustments are easily made while the unit is in operation. Using only clean primary air supplied under pressure, fan maintenance is substantially reduced and fuel piping is greatly simplified. Also, with the pulverizer acting as its own distributor, no special distributing devices are needed. Grinding elements are of special alloy material. They last two years or more on eastern coals and at least a year on midwestern coals.

Adaptable to All Types of Automatic Controls: Because it features "one point contact with the boiler," operation of the B&W Pulverizer is simple. The boiler's automatic combustion control is connected to the pulverizer at only one point—the damper in the primary-air duct. The pulverizer's own control system regulates all other functions, such as maintenance of proper fuel-air ratio and operating temperature.

SEND FOR DATA. For full information about the B&W Type EL Pulverizer and Pulverized-Fuel Firing Systems, write: The Babcock & Wilcox Company, 161 E. 42nd Street, New York 17, N. Y.



COAL RECIRCULATION — this means high fineness, aids drying.

PRESSURE SYSTEM — this eliminates fan wear, simplifies piping.

AIR CONTROL—this means one, simple control contact point.

MILL LEVEL CONTROL — this automatically adjusts fuel-feed.

BABCOCK & WILCOX

BOILER DIVISION

G-766

For more data circle 515 on Post Card

ONE-SHOT "BOILER TREATMENT" GETS UNEXPECTED RESULTS

CEMENT MANUFACTURER SHOOTS THE WORKS!

CLEANING rotary cement-drying kilns by firing lead slugs into them to knock off accumulations inside is routine practice. The slugs go bounding and bouncing through the long drying kiln, doing a cleaning job equivalent to a whole crew of pick-and-shovel pilots. No one expects a slug to become so enthusiastic that it continues its chores inside the waste heat boiler attached to the far end of the kiln. In fact, the odds against getting a slug into the boiler *on purpose* are astronomical. But this one got there, odds and all, thus establishing a new type of one-shot boiler treatment which is hardly likely to become popular.

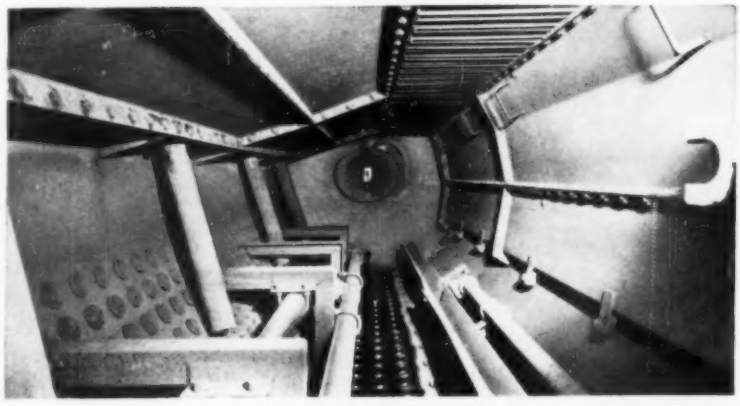
HOWEVER, *inside* the boilers at this large cement plant, Nalco System treatment helps make certain that boiler troubles, if any, are on the outside. Boiler feedwater is aerated, filtered, zeolite softened, evaporated and deaerated. A Nalco corrosion inhibitor is fed between deaerators and feed pumps for corrosion control throughout the steam and condensate return systems. Nalco catalyzed sodium sulfite does the oxygen scavenging on the discharge side of feed pumps. A Nalco internal treatment and caustic soda are fed directly into the boiler for pH control and scale prevention.

It is no wonder these boilers can turn out 169,000 lbs. of steam per hour, year after year, and stay like new—except, of course, for the wayward shotgun slug.

Nalco has not yet developed bullet proofing for boilers . . . But you can never tell what may come next! Meanwhile, we'll be happy to tell you more about effective Nalco Internal Treatment. Ask for Bulletin B1. National Aluminate Corporation, 6224 West 66th Place, Chicago 38, Illinois. In the Northwestern United States, Hawaii and Alaska: The Flox Company, Inc., Minneapolis, Minnesota. In Canada: Alchem Limited, Burlington, Ontario. Branches and affiliates in Spain, Germany and Italy.

THE TREATMENT: Lead slug, propelled by heavy powder charge in 8-gauge shell fired from a miniature cannon! "External treatment" with a vengeance.

THE RESULTS: "Plugged" boiler tube, pierced by lead slug on the pay off to one chance in a million. Internal treatment powerless here.



Steam drum in one of the Nalco-treated boilers at cement plant is typically clean and corrosion-free when opened for annual inspection.

Water treatment chemical mixing and proportioning room, where Nalco System treatment starts on its way to give complete steam system protection against scale and corrosion.

For more data circle 516 on Post Card

HELPFUL BULLETINS

WATER CONDITIONING

101 Ion Exchange Treatment — This Fact-File-Folder discusses importance and advantages of water treatment by ion exchange and describes water treating equipment — deionizers, demineralizers, dealkalizers, softeners and filters. Applications of the various items are pictured and described, and a large fold-out section shows typical installations. H. M. Mueller Corp.

102 Zeolite Water Softener — Features of company's zeolite water softeners which assure efficient, dependable and easy operation are described in Bulletin 28 B7107A. Explains how standard units can be adapted to meet individual requirements where applications involve elimination of maintenance due to scaling of boilers, pipes and heat exchange tubes, and correction of other water problems. Allis-Chalmers Mfg. Co.

103 Hot Process Softeners—Among information contained in 24-pp Publication 4800 is a section on conditions of water that make treatment necessary. Subjects covered in this section are reduction of silica, foaming, priming, and problems of protection against corrosion. Various types of hot process equipment are described and photos, drawings and diagrams illustrating features are included. Cochrane Corp.

104 Tray Deaerator — Bulletin 28B8853 describes a tray type deaerator for effective removal of corrosive gases from boiler feed water. Includes description of the cycle of operation of the tray deaerator, six typical storage arrangements, and provides standard tray deaerator data. Allis-Chalmers Mfg. Co.

105 For Water Testing — Simplified procedures for water analysis, portable test kits, and apparatus and glassware especially selected for water and sewage laboratories are described in 50-pp General Catalog 4. A complete list of chemicals and solutions for water testing is included. Hach Chemical Co.

106 Corrosion Treatment — "Directions For Treating Closed Engine and Compressor Cooling Water Systems," is the title of Data Sheet 730. Listed are factors which influence corrosion of engine blocks, cylinder liner failure due to pitting, and impairment of cooling because of accumulations of corrosion products. Characteristics essential to a good inhibitor are discussed. D. W. Haering & Co., Inc.

FILTERING

107 Filter-Separator — This file of data on company's 15-gpm filter-separator includes a check list of 49 industrial and commercial liquids which can be continuously cleaned by the unit — notably diesel fuels, solvents, refinery control stocks, gasolines, lube oils, boiler feedwater, process intermediates, industrial waters, and marine and aircraft fuels. Drawings show installation and dimensional data, attachments, and external details, and an exploded view illustrates construction. Richmond Engineering Co., Inc.

108 Porous Filters — Porous sintered stainless steel filters are described and illustrated in 12-pp Catalog 54-101. Provides characteristics, application data and specifications and includes selector chart with instructions, plus filtration data tables. The Cuno Engineering Corp.

MECHANICAL POWER TRANSMISSION

109 Speed Variators — Bulletin GEA-6643, 16 pp, illustrated with 4-color photos and diagrams, describes company's line of packaged d-c adjustable speed drives available from 3 through 150 hp, 220, 440, 550 v, three-phase a-c 60 cycle. Included is a power data slide rule for calculating case dimensions, horsepower, speed range, power unit weight, and motor frame size. General Electric Co.

110 Speed Reducers — Standard styles and sizes of double-reduction speed reducers in ratios ranging from 75:1 to 4900:1 are covered in 20-pp Catalog CD-230. Dimensional diagrams are included, as well as a specifications arrangement which makes it simple to select reducer of exact capacity, type and ratio desired. Cone-Drive Gears Div., Michigan Tool Co.

111 Worm Gear Reducers — Bulletin J13 features detailed technical data on company's line of worm gear speed reducers for a variety of industrial applications. The booklet contains a description of various worm gear reducer designs with horsepower ranging from less than 0.1 to 121. Numerous drawings and specification tables show designs and ratings for the standard units. Hewitt-Robins, Inc.

112 Silent Chain Drives — Book 2425 is a comprehensive 88-pp book containing detailed engineering data and illustrations of silent chain's versatility. Contains tables of service factors, ratings, chain length and center distance computations. Pre-engineered stock drives are listed in one 16-pp section. A section of book outlines procedure for selection of engineered drives. Another section on drive components lists available chain widths; chain and wheel dimensions; wheel tolerances, materials and other data. Available to qualified power engineers, please state your job title when requesting this. Link-Belt Co.

113 Flexible Couplings — Bulletin 99 describes applications of company's semi-floating shaft couplings for radial loads such as V-belts, chains, generator or motor armatures. Photos, drawings and diagrams illustrate details of design and operation. Thomas Flexible Coupling Co.

PUMPS

114 Rotary Pumps — Bulletin 2064-B1 describes company's heavy duty rotary pumps designed for efficient and economical service. Includes cutaway views illustrating features, and gives dimensional data as well as typical speeds, capacities, pressure, and power requirements. Worthington Corp.

115 Sand and Slurry Pump — Bulletin 601 gives specifications for company's sand and slurry pump which is lined with replaceable and interchangeable hard metal and rubber liners. A cross-sectional view shows construction details and includes parts list, as well as dimensional diagrams and capacity chart. Krogh Pump & Equipment Co., Inc.

VALVES, PIPING AND ACCESSORIES

116 Solenoid Valves — Form VS-51 contains condensed information on solenoid valves and electromagnetic control for a variety of industrial applications. Categories covered under solenoid valves include two-, three-, and four-way, corrosion resistant, manual reset and special purpose valves. Electromagnetic control categories include automatic transfer switches, remote control switches, contactors, relays, solenoids and electric plant controls. Automatic Switch Co.

117 Steel Gate Valves — This bulletin on cast steel gate valves lists 10 features, stressing durability, easy maintenance and erosion-resistance. Also provides dimension and weight charts and line drawings for each type. A large cutaway drawing illustrates design features. Walworth Co.

118 Plastic Valve — Catalog 42.0 contains essential data on company's all-plastic gate valve, designed for conveying corrosive and abrasive liquids in lines that must be chemically free of contamination. Cutaway views showing design and construction advantages are included. Sizes, dimensions and a graph showing flow characteristics are also given. Vanton Pump & Equipment Corp.

119 Welded Steel Pipe — Eight-pp Bulletin SWP-14457 describes welded steel pipe for industrial uses in diameters from 6 to 36 in., wall thicknesses to ½ in. Applications covered are plant piping, process piping, water supply and sewage disposal. Advantages are listed and pressure design data, dimensions and properties included. Other sections cover welded pipe fittings for flanged pipe, joints, and slip-on type flanges. Armco Drainage & Metal Products, Inc.

120 Stainless Tubing, Pipe — Technical Data Card 188 provides comparative price data for those responsible for the specification and procurement of seamless stainless pipe and tubing. Furnishes analysis details and comparative price ratios of 33 seamless stainless grades using Type 304 (18-8) as a base. Tubular Products Div., The Babcock & Wilcox Co.

Do any of these catalogs answer your operating or maintenance needs? Let us know by circling the number of the catalog on the post card provided on pages 101–102. We'll do the rest!

121 Clamps, Couplings, Joints — This product folder contains a number of individual bulletins on company's line of

band clamps, V-band couplings and joints. Each of the bulletins contains detailed information on applications, sizes and dimensions, as well as photos, dimensional diagrams and installation instructions. Marman Div., Aeroquip Corp.

Reference Reading on Nuclear Equipment

122 Power Plant Of Tomorrow — This 10-pp booklet, Form EBWR-1, describes use of company's liquid level and flow controls at the Experimental Boiling Water Reactor, Argonne National Laboratories. Main theme points up fact that while atomic energy as a power source may be in the future, the same problems are encountered in industry regardless of the end product involved. Actual photos from inside reactor and a simplified flow diagram explain functions of each of the safety controls. Magnetrol, Inc.

123 Nuclear Plant Instrumentation — Eight-pp Booklet B-7233 describes complete instrumentation and control for all-nuclear plants. Illustrated with many control photos and schematics, the booklet covers in detail reactor power control, reactor nuclear instrumentation, reactor coolant instrumentation and radiation monitoring. Westinghouse Electric Corp.

124 Piping For Nuclear Energy — Information on stainless steel and special purpose alloy tubing and pipe for use in nuclear energy applications is given in illustrated Bulletin TD-123. Lists 34 different analyses which can be supplied for use in equipment for atomic energy field. Discusses several nuclear energy installations and the analyses and shapes of tubing and pipe used in each. Alloy Tube Div., The Carpenter Steel Co.

125 Filters For Nuclear Uses — This folder covers some of the nuclear fluid problems and their solutions. In addition to discussing the filtration requirements of the nuclear field, it illustrates and describes filter media for various uses. Purolator Products, Inc.

VENTILATING AND AIR CONDITIONING

126 Centrifugal Fans — Bulletin 257, 32 pp, gives engineering data on company's BC Airfoil fans and illustrates construction details of fans for all types of ventilating and air conditioning installations. Comparative performance graphs show why greater efficiency and quieter operation are obtained. Capacity tables, dimensional drawings and suggested application arrangements are given for each model. Also included are rating tables on motors, sample fan specifications, laws of fan performance, and other data. Ilg Electric Ventilating Co.

127 Inductor Air Conditioners — Bulletin 8827, 16 pp, describes inductor air conditioners for perimeter air conditioning of multi-storied buildings. Outlines and illustrates features and characteristics, covering installation, adjustments and controls. Table of basic unit ratings, primary air rating curves, heating and cooling capacity indices, a table of gravity heating capacities, coil water friction values, pressure drop curves for orifice size selection are included. American Blower Div., American-Standard.

128 Airfoil Fans — Catalog 1121, 12 pp, describes efficiency and quietness of airfoil blading for all-purpose applications in a standard line of centrifugal fans covering requirements up to 700,000 cfm and up to 16¾ in. total pressure. Selection charts are included, and block dimensions and fan arrangements are detailed. Westinghouse Electric Corp.

INSTRUMENTS AND CONTROLS

129 Basic Controls — Nine basic types of temperature and pressure controls are described in this 12-pp condensed catalog. Covers self-operating regulators, water mixing equipment, pneumatic control instruments, indicating and recording instruments and control valves. Equipment is designed for industrial process control, also for heating, ventilation, and air conditioning systems, and hot water service applications. Powers Regulator Co.

130 Electronic Process Control — This series of four bulletins features details on company's electronic process control instruments for indicating, recording, and controlling temperature, pressure, level flow, pH, etc. Tables of specifications are included with statements of proportional band, reset and rate performance, spans and adjustability. Bulletin A-801 covers Unitized Autronic Control in general, with separate bulletins on controller, manual control unit, and recorders and indicators. The Swartwout Co.

131 Rate-of-Flow Instruments — Bulletin M-1 pictures and describes company's line of precision instruments for measuring, indicating, recording, and controlling rate of flow of all types of fluids. Included are detailed descriptions of various types of rotameters and flow indicators. Instrument Div., Schutte and Koerting Co.

132 Rate-of-Flow Controller — Bulletin 900, 12 pp, contains data on details of design, capacities, dimensions, and typical installation of company's Type S rate-of-flow controllers. Included are dimensional diagrams as well as specifications. Simplex Valve & Meter Co.

133 Versatile Indicators — Bulletin MSP-134, 8 pp, describes company's MP Indicator, a versatile multi-point instrument for measuring a complete range of draft, pressure, and differential. Photos illustrate component features, and sections on types of elements, mounting diagrams and dimensional data are included. Hagan Chemicals & Controls, Inc.

134 For Temperature Control — Six-pp Bulletin 655 shows how to select, size and order temperature control valves. Includes information on selecting proper body material, valve trim, thermal system, etc. Detailed but simple formulae and examples are used. Jordan Corp., Industrial Sales Div., OPW Corp.

135 High Vacuum Gages — Bulletin 9-1, 23 pp, describes a broad line of high vacuum gages, including an absolute manometer, thermal gages, ionization gages, and a combination thermal-ionization gage. Pertinent data is given in a graph of pressure ranges and a gage data table. Detailed descriptions of the various types of gages in the line are included. Rochester Div., Consolidated Electrodynamics Corp.

136 Boiler Control System — Covering all types of fuel burning systems, this manual deals with fuel loss — smoke, soot, and fly ash expulsion — boiler capacity and maintenance — operating safety, etc. It includes a preliminary boiler operation survey which makes it possible to closely estimate preventable fuel loss. Fuel Reduction Engineers, Inc.

137 Magnetic O_2 System — Application Data Sheet 463-60 describes company's magnetic O_2 system for flue gas analysis. Components of system are described and system advantages detailed. Leeds & Northrup Co.

GASKETS, SEALS

138 Rotary Seals — Bulletin ML-177, 6 pp, describes functions and applications of company's Rotorseals, used as a means of transmitting air, liquid or gases under pressure, or vacuum from a stationary source into a rotating shaft. It also includes data on quick release valves, used to provide quick evacuation of pressurized air from pneumatic systems. Fawick Airflex Div., Fawick Corp.

139 Spiral-Wound Gaskets — Bulletin AD-104, 12 pp, on company's spiral wound metal gaskets, details outstanding features and design factors of the metal gaskets as well as types available for specific applications. Sizes are listed and charts for suggested sizes in relation to pressures sealed are included in the bulletin. The Garlock Packing Co.

ELECTRICAL

140 Power Packed Motors — Sixteen-pp Bulletin 6602, illustrated in color, introduces company's Tri-Clad 55 line of motors in ratings from 7½ to 125 hp. Text and drawings explain why these compact motors outlast, outperform and are more easily installed and maintained than many motors. Standard, dripproof, TEFC and special models are shown. Full data on ratings, sizes provided. General Electric Co.

141 Specialized Drives, Motors — Twelve-pp Bulletin A-2400 covers in text and illustrations this company's specialized drives and motors engineered to rigid specifications. Covered are integral a-c motors to 400 hp; d-c units to 1000 hp; d-c and a-c generators and motor-generator sets; gearmotors and variable-speed drive systems and their control. Reliance Electric and Engineering Co.

142 Distribution Transformers — Bulletin 137, 12 pp, describes four major types of dry-type distribution transformers and includes detailed engineering data. Photos, drawings, mounting diagrams and voltage ratings are given. R. E. Uptegraff Mfg. Co.

143 Germanium Rectifiers — Bulletin GEA-5773C, 6 pp, tells how to select and apply fan-cooled and blower-cooled germanium rectifiers. Tables, charts, line drawings, and photos are included to tell the story of parallel and series operation, to indicate operating characteristics, to give dimensions, ratings and model numbers, and to offer information on special features of these component rectifiers. General Electric Co.

Valves for Power Plants

Fig. 1314 A—1500-Pound Integral bonnet steel "Y" Valve.

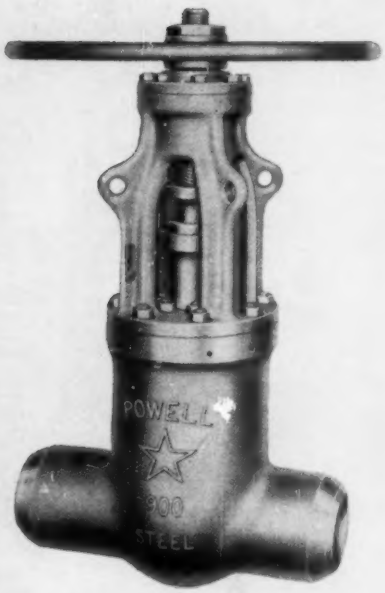


Fig. 19003—Powell Steel Pressure Seal Gate Valve for 900 pounds W.S.P.

Fig. 375—Bronze Gate Valve for 200 pounds W.S.P. Union bonnet, inside screw rising stem.

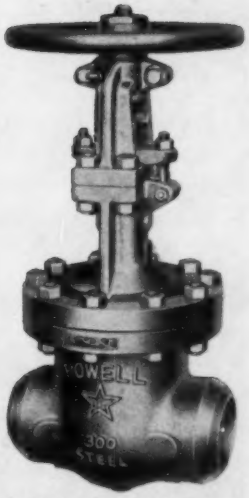


Fig. 3003 WE—Steel Gate Valve for 300 pounds. Outside screw rising stem and yoke.

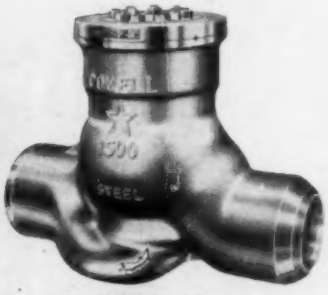


Fig. 11365—Steel Pressure Seal Horizontal Lift Check Valve for 1500 pounds.

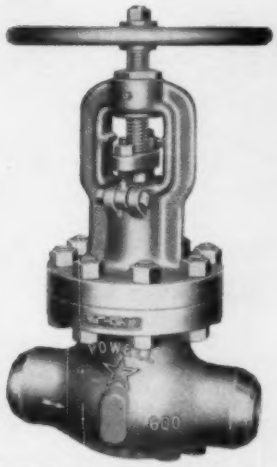


Fig. 6031 WE—600-Pound Steel Globe Valve for steam service. Outside screw stem and yoke.

POWELL...

world's largest family of valves

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

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"OUT IN THE OPEN"

Vogt

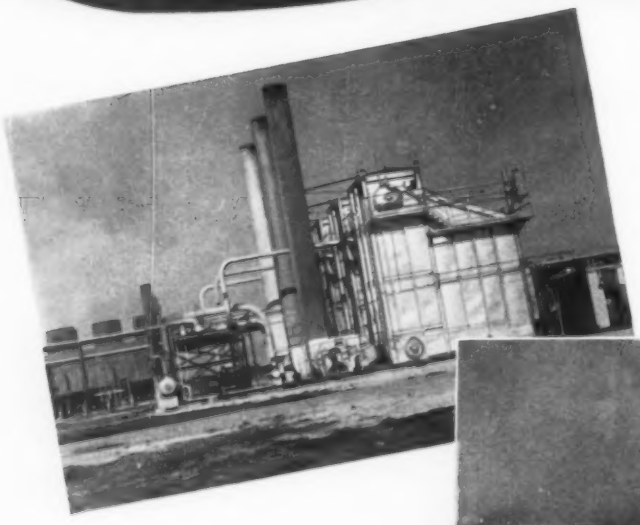
Steam Generators

for
CHEMICAL PLANTS
and
PETROLEUM REFINERIES

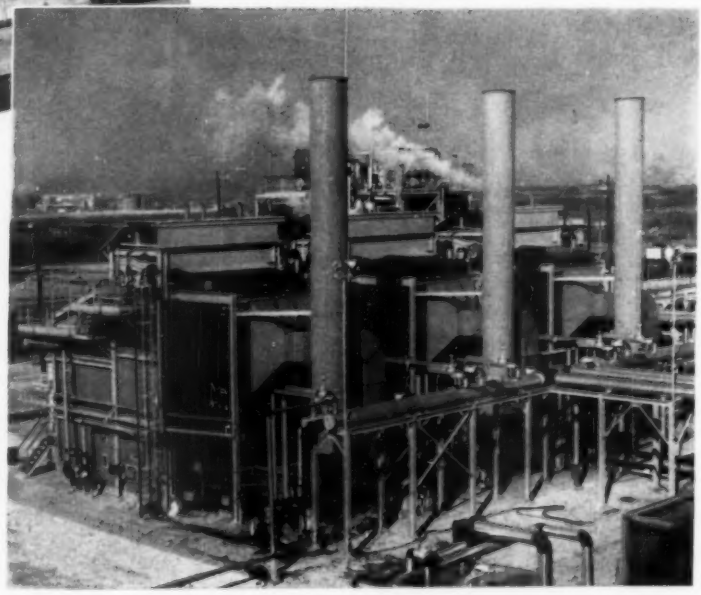
STEAM GENERATORS for economical outdoor operation have been featured by Vogt for many years and serve leading chemical plants and petroleum refineries. Requiring no building for housing, such installations, as pictured here, produce more steam per dollar of investment and are a definite aid to lower production costs.

Get Vogt's recommendations for steam generators to meet your needs for power, processing, or heating, without obligation. Package type and custom built units are available in a wide range of types, capacities, and pressures to meet operating requirements.

Write for bulletins. Dept. 24A-BPE



Three 85,000 #/hr. steam generators in a Texas refinery.



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144 Substation Library — Now being reissued is this manufacturer's unit substation technical library. Seven individual publications in the set discuss problems and solutions relating to: distribution substations in system planning (GER-1151); economical size substations for 12-kv distribution system (GER-1299); converting a radial to a primary network distribution system (GER-1313); master unit substations and relay and control arrangements (GET-2528); integrating substation and system planning requirements to reduce over-all investment (GET-2677); use of handbooks for planning purposes (GEZ-1867) and twenty-five years of progress in unit substations (GEZ-1865). The library is available to qualified power engineers. Please state your job title when requesting it. General Electric Co.

145 Distribution System — Catalog 10, 24 pp, describes Uni-Bus plug-in, "shelf-engineered", power distribution systems for three- and four-wire, 600-v service. Explains how "shelf engineered" components simplify design and installation by eliminating need for specially engineered busway components. Includes specifications, photos, dimensional diagrams, layout procedures, and voltage-drop curves. Electric Distribution Products, Inc.

146 For Power, Lighting — Company's Type RR cable for many types of installations — indoor, bus or conduit, aerial, buried — are presented in this bulletin. Gives sizes for both shielded and non-shielded types. Stresses construction of the cable, describes insulations available. Triangle Conduit & Cable Co., Inc.

147 Mineral Insulated Cable — This 12-pp brochure describes the merits of safety mineral insulated cable as well as its electrical and physical properties. Installation and wiring data are included, as well as numerous photos, drawings and diagrams showing design and construction features. General Cable Corp.

148 Cable Supports — This informative folder contains data on company's cable supporting equipment, telling how to install cable supports, as well as pointing out advantages of using cable trough. A list of sales representatives is included. T. J. Cope Div., Rome Cable Corp.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 101 and 102.

149 Instrument, Control Switches — Construction features of company's instrument and control switches (Type 210) and their advantages are described in 8-pp Bulletin 14B 8112A. Includes operational information, a description of various components, dimensions of modern, heavy duty, removable handles and dial face plates, along with cover take-off dimensions. Allis-Chalmers Mfg. Co.

150 High-Frequency Capacitors — Bulletin GEC-1346B, 6 pp, describes company's Class HF water cooled high-frequency capacitors and discusses power factor improvements in circuits operating at frequencies from 500 to 12,000 cycles. Performance data, dimensions, drawings

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Roto Hand-hole Seat Scraper for B & W Boiler.

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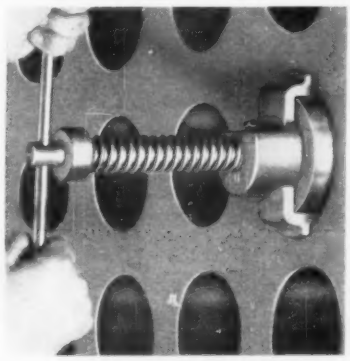
Assures clean, tight fit

Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. *Send for details.*

Now available

for most hand-hole shapes and sizes

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox ≠ 4	Round	2"
" " " ≠41	Oval	2"
" " " ≠70	Round	3"
" " " ≠48	Oval	3½"
" " " ≠40	Oval	3¼"
" " " ≠24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

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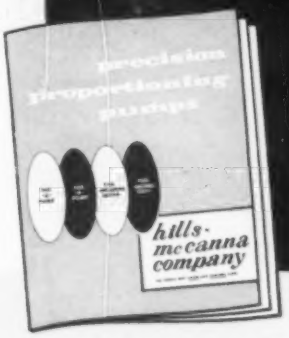

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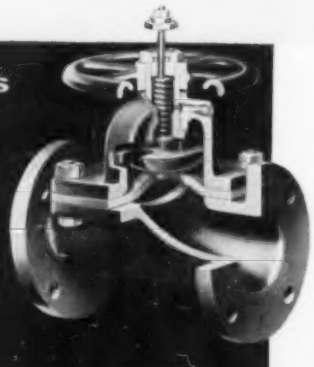

Hills-McCanna Company, 4620 W. Touhy Avenue, Chicago 30, Illinois

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and wiring diagrams, charts and pictures are included. General Electric Co.

151 Loadbreak Tool — Bulletin 731, 10 pp, provides complete details on company's portable loadbreak tool, designed for load switching anywhere on distribution systems. Application and performance details are fully covered, as well as operation, construction and complete specification data. S & C Electric Co.

ENGINES, GENERATORS

153 Steam Turbine Generators — Versatility in design and application of company's medium capacity steam turbine-generator units is described in 54-pp Bulletin GEA-3277D. Contains information and data on condensing turbines utilizing either non-reheat or reheat; noncondensing turbines; single, double and triple automatic extraction turbines; admission units; and admission-extraction steam turbines. Construction features dealing with use of either hydrogen gas or air for the cooling medium are explained. Nomographs of approximate steam rates are included. General Electric Co.

154 For Hydro Plants — Use of synchronous generators for hydro-electric generation of power is the subject of 24-pp Bulletin P.B. 2800-1. Diagrammatical details illustrate construction of two vertical types of generators: suspended construction for machines of 240 rpm and above, and umbrella construction for machines below 240 rpm. Data on horizontal-shaft generators are also presented. Elliott Co.

155 Free-Piston Engine — Detailed specifications and estimated performance data on company's turbocharged, free-piston engine are featured in this 36-pp booklet. Traces development, under continuing program of research and development, through 5 free-piston-engine designs developed by company. Diagrams, specifications and performance characteristics are presented, along with cutaway diagrams and other data. Hamilton Div., Baldwin-Lima-Hamilton Corp.

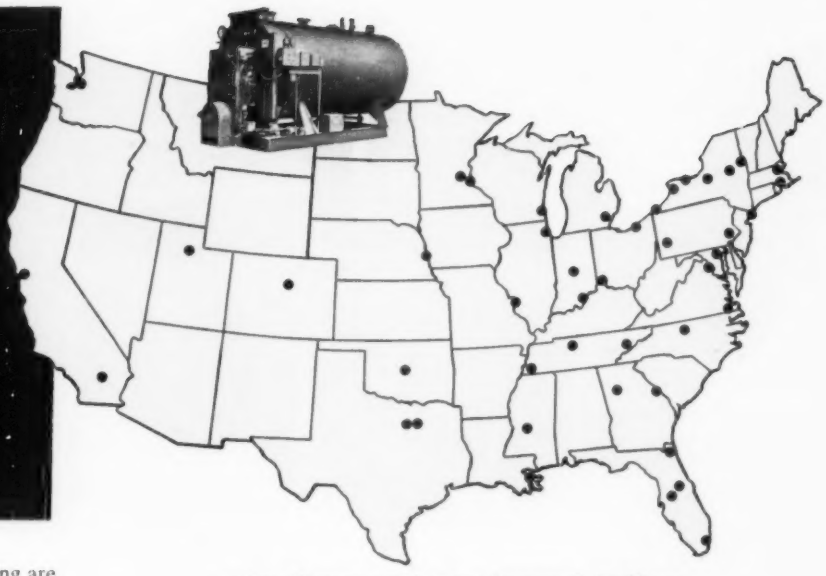
OTHER EQUIPMENT

156 Air Pollution Control — Successful applications of catalytic oxidation to four difficult air-pollution control problems are reviewed in this technical reprint. Details actual installations in carbon black, insulation, oil-refining and chemical processing industries — applications where, in addition to gaseous pollutants, aerosols, inorganic dust, and hard-to-oxidize components are encountered. Photos, charts, flow diagrams supplement text. Oxy-Catalyst, Inc.

157 Steam Heating Coils — Catalog 1715, 12 pp, describes advantages and applications of company's heavy duty steam heating coils. Includes selection data and suggested piping arrangement, as well as diagrams and general description of the steam heating coils. Sturtevant Div., Westinghouse Electric Corp.

158 Tube Coating Oils — Power engineers involved with procurement, storage and fabrication of welded carbon tubing will receive benefits from the concise information on protective coatings furnished by ERW-TSL 3. It describes in detail various protective coatings and indicates conditions under which such coatings will supply the required protection. Tubular Products Div., The Babcock & Wilcox Co.

Continental Boiler Service Coast to Coast



The basic fundamentals of learning are the ABC's. Therefore, when your subject is boiler service — Continental Boiler Service — we believe it essential that you become familiar with the ABC's of Continental Service from coast to coast as follows:

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B . . . Boiler Operating Instruction to Attendants.

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See list at right for the capable, service-minded Continental Boiler representative near you.

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Palm Springs—Pacific Engineering Equipment Co.
COLORADO
Englewood—Champion Specialty Co.
FLORIDA
Jacksonville—H. L. McMurry & Co.
Miami—H. L. McMurry & Co.
Orlando—H. L. McMurry & Co.
Tampa—H. L. McMurry & Co.
GEORGIA
Atlanta—Atlanta Distributing Co.
Atlanta—Mechanical Associates
Augusta—Tarte Boiler Repair Co.
ILLINOIS
Chicago—Automatic Steam Sales Co.
INDIANA
Indianapolis—Plibrico Sales & Service Co.
New Albany—Falls Cities Boiler & Machine
LOUISIANA
New Orleans—Cressy Sales Company
MARYLAND
Baltimore—Heating Services, Inc.
MASSACHUSETTS
Dorchester—Lewis National Corp.
MICHIGAN
Dearborn—Kramer & Associates, Inc.
MINNESOTA
Minneapolis—Oil Burner Service Co., Inc.
St. Paul—Lincoln Equipment Company
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Jackson—Climate Engineers, Inc.
MISSOURI
St. Louis—Continental Boiler & Sheet Iron Works
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Omaha—Midwest Utility Service Co., Inc.
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Hudson Falls—Boiler Equipment Co.
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Providence—Weatherall Engineers, Inc.
TENNESSEE
Knoxville—Boiler Supply Co.
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Nashville—Boiler Supply Company
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UTAH
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VIRGINIA
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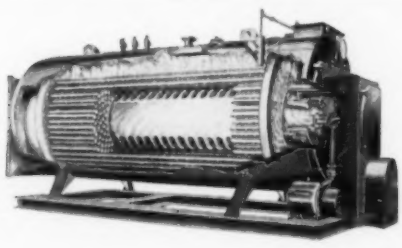
Milwaukee—Industrial Steam, Inc.

BOILER ENGINEERING & SUPPLY COMPANY, INC.
3 Manavon Street, Phoenixville, Pa.

The Continental AUTOMATIC BOILER



Cut-away view of typical Series A Continental Automatic Boiler, firing oil and/or gas. Other models from 20 to 500 hp, with on-off, low-high-low or modulating controls. For steam heating or process work at pressures from 15 to 250 pounds, or for hot water heating at low or high temperatures.

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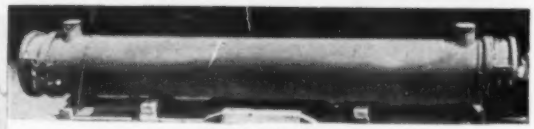
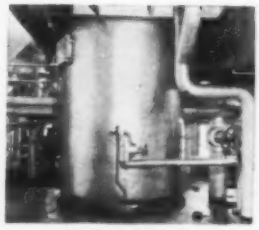
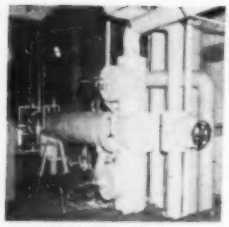


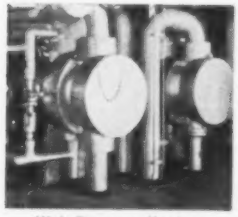
Condensate Cooler



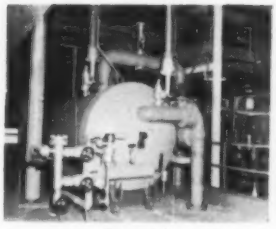
Vertical Deaerator



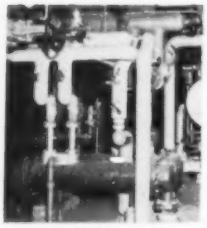
Feedwater Heater



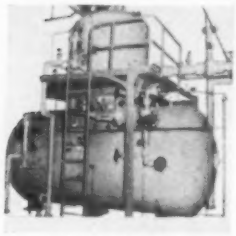
High Pressure Heaters



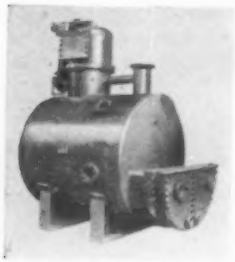
Evaporator



Steam Jet Air Ejector



Horizontal Deaerator



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159 Metal Grating Handbook — This metal grating handbook contains 32-pp of informative text, schematic drawings, tables, and installation photos as well as standards and specifications. Also contains a glossary of terms and definitions used throughout the industry. Designed to establish standards and specifications for design and usage, the book represents a complete product standardization in the metal grating industry. It is not a manufacturers' catalog but rather a technical guide prepared by the industry itself. Metal Grating Institute, Inc.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

160 Duct Insulation — Engineering data and application instructions for spun mineral wool duct insulation, for application to heating and air conditioning ducts up to 450 F, are presented in this bulletin. Thermal conductivities and sound absorption coefficients are tabulated. Physical, chemical, mechanical and handling properties are also described. Baldwin-Hill Co.

161 Steel Smoke Stacks — Advantages of steel smoke stacks are detailed in this illustrated bulletin, along with a list of typical installations. Size and capacity data are given, as well as formula for figuring anchor bolts for self-supporting stacks, formula for figuring guy wire for guyed stacks, and force of wind data. L. O. Koven & Brother, Inc.

162 Oil Heater — Form RE-363 is an illustrated brochure describing features of company's Hi-Heat oil heater. A large cut-away view illustrates internal construction and a table provides specification data. Bros Inc.

163 Hot-Pipe Insulation — Advantages of an underground pipe insulation system in which an insulating concrete is poured directly and monolithically around underground hot pipes are detailed in this 12-pp folder. Among information furnished are thermal and structural characteristics, control of pipe expansion, sequence of installation, and specifications. Z-Crete Div., Zonolite Co.

164 Protective Wells — Complete data on wells for thermostat applications in fluids, gases, or high pressure environments are included in this catalog. Illustrates and describes copper and stainless steel designs. Fenwal Inc.

165 Welding Supplies — Presented in Catalog 9-13 are 48 pp of information on welding supplies and accessories. Among items covered are ferrous and non-ferrous welding rods for oxyacetylene welding and Heliwelding, welding and brazing fluxes, aluminum welding fluxes, silver brazing alloys, and such protective equipment as goggles, glare protection spectacles, welding helmets and face shields, hard hats, leather gloves. Air Reduction Sales Co., Div. of Air Reduction Co., Inc.

Power Engineering

ATOMICS

308 EAST JAMES STREET
BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

December 1957

Fifteen Years Ago. These lines are being written on the afternoon of December 2. Exactly fifteen years ago this afternoon the atomic age began. On the afternoon of December 2, 1942, beneath the west stands of Stagg Field at the University of Chicago, a small group of scientists witnessed the advent of a new era. Precisely at 3:25 p.m., George Weil withdrew a cadmium-plated rod from the first atomic pile, and by that action, man unleashed and controlled the atom.

As those who witnessed the experiment became aware of what had happened, smiles spread over their faces and a quiet ripple of applause could be heard. It was a tribute to Enrico Fermi, Nobel Prize winner, to whom, more than any other person, the success of the experiment was due.

The story of that first atomic pile (only later were they called reactors) and the events of that cold December afternoon are now well known. It has been told many times. This experiment was a key part in the world development of atomic energy. Its success initiated the atomic bomb project and today it remains the basis of the world-wide interest and activity in the development of atomic power.

When we contemplate this world-wide activity in the development of atomic power or nuclear power as we like to call it now; when we remember the devastation of Hiroshima and Nagasaki brought about by the first small bombs of the atomic age, and later the incomprehensible destructive force of the hydrogen bombs; when we consider the thousands of volumes, the hundreds of thousands of papers and articles that have been written on the subject of atomic emergy; the billions of dollars that have been spent; the scope and complexity of the vast nuclear industry that has grown up with all its political and social ramifications - when we think about all these things and many more, then it seems almost incredible that it all started a mere fifteen years ago.

The Historical Perspective. Actually, of course, the story of atomic energy started long before that afternoon when the first self-sustaining nuclear chain reaction was initiated. While Fermi's part was large and important, no one man deserves the credit for the achievement. Fermi was the directing chief, but co-operating groups in nearly all the universities, industries, and technical centers in the nation had done work that made it possible to collect the necessary material. The achievement of the first self-sustaining nuclear reaction was the brilliant culmination of a series of events that began in a letter to the editor of Nature, published in the issue of February 11, 1939, by two refugee scientists who had been hounded out of Germany by Hitler and his gang. One was a woman, Professor Lise Meitner, who had taken refuge in the Physical Institute of the Swedish Academy of Sciences in Stockholm. The other, Dr. O. R. Frisch, had found a welcome in the Institute of Theoretical Physics of the University of Copenhagen. Both were nuclear physicists and their

letter was titled "Disintegration of Uranium by Neutrons: a New Type of Nuclear Reaction."

In this letter they summarized a state of confusion which had built up around the effects that were observed when uranium was bombarded with neutrons. Fermi had done this as early as 1934 and had found in the residue certain elements that simply did not make scientific sense. He found that such bombardment gave rise to at least four radioactive substances. Others were quick to take up this line of investigation, among them Professor Meitner herself, then still working in Berlin with Professor O. Hahn.

During 1938, Hahn and a colleague, F. Strassmann, discovered what they thought was an isotope of radium in the uranium products after neutron bombardment. They were much distressed, however, when some work of Mme. Joliot-Curie and a co-worker showed that it could not possibly be an isotope of radium, that it must be an isotope of a much smaller atom - possibly barium with atomic number 56. Remember, uranium has atomic number 92.

So Hahn and Strassmann went back to their test tubes to check this suggestion, and no one could have been more astonished than they when they found that it was indeed barium which they had mistaken for radium. Contritely they confessed their error in a paper published early in January 1939. As chemists they had to accept the evidence that it was barium but from a nuclear standpoint it still did not make sense. How could a big atom like that of uranium be cut down to a much smaller one such as barium?

But it did make sense to Meitner and Frisch. As soon as they read Hahn's paper in January, they had the answer. Their own letter to the Editor of Nature was dated, January 16, 1939 and in it they say: "It seems therefore possible that the uranium nucleus has only small stability of form, and may, after neutron capture, divide itself into two nuclei of roughly equal size . . ."

Furthermore, Lise Meitner understood the implications of Einstein's mass-energy equation $E = MC^2$. In their letter to the Editor, they, continued, "These two nuclei formed by the fission of the uranium atom should gain a total kinetic energy of about two hundred million electron-volts".

Here was atomic energy.

The Missing Mass. What Meitner and Frisch had done was to compare the mass of the uranium nucleus with that of the resulting fission fragments. The atomic masses of all the elements were, of course, well known. And they found that the total mass of the fission fragments was somewhat less than the mass of the uranium atom from which they had been formed. The missing mass had been converted into energy. Thirty-five years before, Albert Einstein had said this could happen, and Meitner's calculations based on the experimental data of Hahn and Strassmann were in complete agreement with Einstein's predictions.

It so happened that early in January 1939, Professor Niels Bohr was on his way to the United States but just before he left Denmark he had heard from Frisch and Meitner about their theory of uranium fission. The famous physicist naturally was much excited by this news and as soon as he arrived in the United States he passed the thrilling news on to his fellow physicists. From a scientific standpoint, this, of course, was world shaking and the news spread like wildfire throughout scientific circles throughout the world. Physicists in laboratories all over the world immediately set up equipment to obtain experimental verification of the theory.

Confirmation came almost immediately and simultaneously from a number of countries. Scientists everywhere abandoned what they were doing and began detailed experimental work on nuclear fission and papers and communications by the hundreds swamped editors of scientific journals. Nuclear fission had been proved but there was still a more important question to be answered, and it was this:

When the uranium nucleus splits, would the process release additional neutrons? This was even a more exciting idea than fission itself because if additional neutrons were produced, such neutrons might cause other uranium atoms to split, and thus a chain reaction would result. Fission without a chain reaction would be like bowling on an alley on which the pins were set so far apart they could not possibly hit each other. Under such conditions it would take a great many throws to hit a few pins.

Now, there was a good chance that additional neutrons would be produced. It was known that the heavier atoms such as uranium had more neutrons in their nuclei in proportion to the number of protons, than in the case of lighter atoms. In the elements in the lower end of the periodic table, the number of protons and neutrons in the nuclei is equal. As we go upward in the periodic table, towards the heavier elements, it is found that the nuclei carry a preponderance of neutrons over protons. The nucleus of uranium-235, for example with an atomic weight of 235, contains 143 neutrons but only 92 protons. Hence, it was reasoned, that if such a nucleus splits into two roughly equal parts, the resulting fragments could not carry a proportionate share of excess neutrons and that such excess neutrons would be released.

Neutrons in an atomic nucleus can be discharged in other ways. Since a neutron can be thought of as a proton which has swallowed an electron, a neutron can throw off an electron and thus change into a proton. This is called beta decay.

In the fission process it seemed probable that both processes would take place, that is, some of the neutrons in the fragment nuclei would emit electrons and thus change into protons (and thereby raising their proton count) while others would be emitted bodily. These latter neutrons then would be available to carry on the process of fission in other atoms. There was every reason for believing that the fission of one uranium nucleus would give rise to several free neutrons, each of which could split other nuclei and thus carry on the process ad infinitum.

Fermi, a political refugee from Italy, at that time was a professor at Columbia. When Niels Bohr told Fermi about the Meitner-Frisch theory, Fermi immediately suggested that if such a reaction actually could be achieved, it might result in a self-sustaining nuclear reaction.

This then was the beginning of the series of events which culminated in the historic occasion at the University of Chicago on December 2, 1942. By the end of 1939 the war had started, and on December 7, 1941 Pearl Harbor shattered our own complacency. As early as July 1939, sensing the immense implications of atomic energy in war, Albert Einstein sent his now-famous letter to President Roosevelt urging the importance of giving official backing to atomic energy research. From there on, things moved quickly - it was feared that if we did not develop the atomic bomb, Hitler would, and the race was on.

Why this History? All this, of course, is history, many of us are quite familiar with it. My reason for retelling it now is that it is helpful at times to stop and see just how far we have come - where we stand on the road of progress. Often, we travel too fast to appreciate the details of the landscape. The perspective we get when we look back sometimes gives us a better understanding of the road ahead.

The face of atomic energy has two sides; one good, the other evil. We all know the evil side and need say little about it. We remember Hiroshima and Nagasaki, not with pride but as one of the grim necessities of war. War compels us to do things we do not like. It may be recalled that it was one of the world's great and most ardent pacifists who initiated the impulse that set the atomic bomb project in motion - Albert Einstein, with his letter to President Roosevelt.

Einstein had no alternative, nor did the many other scientists in the atomic bomb project. Hitler had made the selection for them. As soon as the news of uranium fission became known, it was thought certain that the Germans would go all out in an effort to develop an atomic bomb. As it turned out, their efforts were

meager compared to ours but we did not know that. So it left us with no alternative, we had to develop the atomic bomb.

U-235 or Plutonium. There were two ways of making an atomic bomb. One was by separating uranium 235 from natural uranium, while the other involved the production of plutonium in a nuclear reactor. We used both, but if the separation of U-235 had not been so very difficult it is unlikely that we would have developed the nuclear reactor at the time we did. Ultimately, of course, we would have, but the urgency of war gave us no choice but to try both. So it is fortunate that we did because it is the atomic reactor that gives us the promise of nuclear power for peaceful purposes. The knowledge and the techniques that we gained in the construction of the first Argonne and Oak Ridge reactors, and the large plutonium production reactors at Hanford, provided the base upon which the present vast atomic power industry is built.

There are those today who seem impatient with our rate of progress in the development of nuclear power, at least on this side of the Atlantic. It is, of course, a question of economics; there is not the same sense of urgency that drives us on to the large scale development of nuclear power stations that there was during the war years to develop the atomic bomb.

But, looking back to December 2, 1942, it will be seen that we have come a long way in the use of the peaceful atom. Until that afternoon we were not sure that the search for a k factor greater than 1 would be successful. The whole success of the nuclear reactor hinged on being able to attain a reproduction factor k greater than 1. As Smyth wrote in his famous report, if k, the neutron multiplication factor could be made greater than one in a practical system, the project would succeed; if not, the chain reaction would never be more than a dream. Luckily it was greater.

War is destructive but it also stimulates and makes possible in short times developments that otherwise might take decades. Private industry could never have financed, nor secured the necessary physicists and technicians that it took to produce the first chain reaction. When the war ended and the atomic bomb was a reality, we had accumulated a vast plant and a great body of scientists and engineers versed in the techniques of the atom to use in the even more difficult task of developing nuclear power.

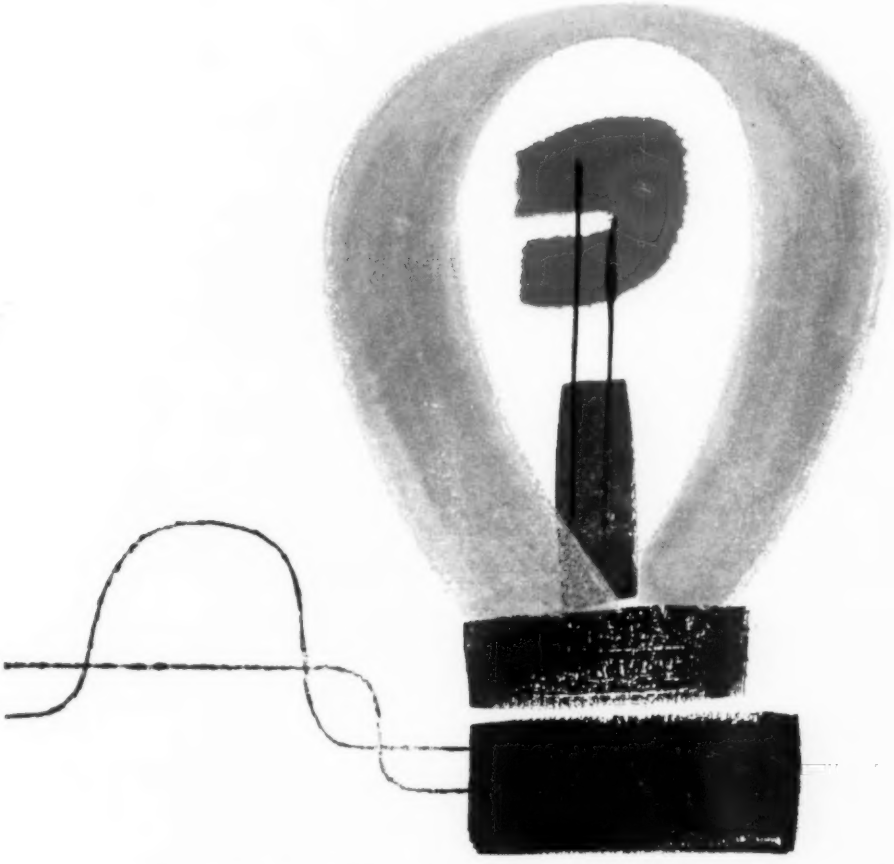
The design of power reactors is still fraught with many unknowns, even in types already in use. Many factors such as the effect of changes in physical dimensions due to temperature variations, the behavior of materials under thermal stress and high neutron flux, remain to be investigated but, today, we have the knowledge, the skill, and over 15 years of continuous experience to help us. In view of the immense accomplishments of the past in the field of nuclear energy, we should have little doubts as to the ultimate success of future still more difficult projects - projects such as the development of a controlled thermonuclear reaction.

A. W. Kramer

The ATOMICS Technical Letter presented on these pages has been published periodically since March 1954. It has been mailed free of charge to a small but select group who maintained an active interest in the field of nuclear energy development. Because of the growing importance of nuclear energy in the power industry we now feel that this letter will be of interest to a large proportion of the readers of Power Engineering and for this reason it will be published as a special feature in every other issue of POWER ENGINEERING. Also, as announced in the December issue, a much more comprehensive section on ATOMICS will appear in the other alternate issues. In these two special features we will endeavor to cover all aspects of nuclear development in language that practical engineers can understand.

A. W. Kramer

call KE for plant expansion or new facilities



INGENUITY

has made KE a major builder of dependable power facilities

100,000 kw steam power plant now under construction at Josephtown, Penn., for St. Joseph Lead Company, a large American lead and zinc producer. The new turbo-generator plant is being designed and built by KE's thermal power plant specialists.

Since installation, no unscheduled outages have occurred in power plants built by Kaiser Engineers. On the contrary, in numerous cases KE-built plants have fed power into neighboring systems temporarily "down."

Preventing outages, building in reliability that insures against service interruption—these are benefits of engineering and construction ingenuity as surely as are low initial cost, fast completion, and low operating cost.

Experienced KE engineers can take your power plant idea from conversation through completion; conduct every phase from economic analysis through operator training. Whether your future power needs are thermal or nuclear, call KE.

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CONSTRUCTION NEWS

El Dorado, Ark. — Lion Oil Co, Division of Monsanto Chemical Co, 1700 S Second St, St. Louis, Mo., has announced plans for the construction of a new reformer unit at company's El Dorado refinery. The addition will be a catalytic reformer with throughput capacity of 5000 barrels of charging stock per day. The new installation will include a hydro-desulfurization unit and a 100,000-lb-per-hr steam boiler. The reformer will convert low octane straight-run gasoline into higher octane material. Location of the new units is within the present refinery area. Site clearance and other preliminary work will get under way at once. Actual construction work will begin in early 1958 for 1959 completion. No estimate of cost announced.

Pine Bluff, Ark. — Arkansas Power & Light Co, Simmons National Bldg, and twelve other independent electric power companies in the states of Arkansas, Kansas, Louisiana, Mississippi and Oklahoma, have formed an organization to be known as the Southwest Atomic Energy Associates. Newly formed company is undertaking a research and development program aimed at practical use of atomic energy as a supplemental fuel for future electrical needs of the area. Corporation ultimately plans construction of one or more large atomic power reactors, with electrical capacity of between 200,000 kw and 400,000 kw, each. Company now has under active consideration a program of research and development, reported to cost in excess of $5,000,000.

Burbank, Calif. — City Public Service Department, 164 W Magnolia Blvd, has plans under way for extensions and improvements in municipal steam-electric generating station, including installation of equipment for increased capacity. City has awarded contract to the Fluor Corp, Ltd, for construction of a 4000-kv steam-electric generating unit, at a reported cost of $7,000,000. Work will get under way soon for completion in 1959.

Los Angeles, Calif. — Department of Water & Power, 207 S Broadway, has arranged financing in the amount of $18,000,000, major portion of which will be used for expansion and improvement of city's steam-electric generating facilities, hydroelectric power development and for extensions of distributing system. Other lesser expenditures will incur work on additional power substations and transmission lines and other miscellaneous construction.

Pleasanton, Calif. — The world's first privately financed nuclear electric power plant was placed in operation recently. Plant located at General Electric Vallecitos Atomic Laboratory in Alameda County, near here, is powered by uranium fuel, and is a joint venture of Pacific Gas & Electric Co and General Electric Co. Power plant has an initial capacity of 5000 kw. A turbine, driven by nuclear-generated steam, produces the electricity. When placed in operation in October 1957, everything was reported to be operating perfectly.

Denver, Colo. — Public Service Co of Colorado, 15th and Champa Sts, has authorized plans for the construction of a 250,000-sq-ft home office building, to be used as company headquarters and operations building, including repair and maintenance department, and other mechanical divisions. Cost reported close to $5,000,000. Proposed to begin work at an early date.

Atlanta, Ga. — Georgia Power Co, 52 Fairlie St NW, has authorized plans for the construction of new company headquarters building, to be used as a general service headquarters and administration building. Work on the new structure will get under way soon under supervision of the Dalon Construction Co, and will cost an estimated $3,750,000 when completed. Stevens and Wilkinson, also of this city, are the architects.

Boise, Idaho — Idaho Power Co, 1220 Idaho St, has arranged a proposal to the SEC for financing in part of company's Snake River Dam projects which have recently excited Congressional controversy. Company plans to raise a fund of $17,250,000, through sale of bond issue. Company has previously announced plans for the expenditure of $75,694,000 on construction in 1957 and 1958. Company reports that the total cost of the Snake River projects, dams at Brownlee, Oxbow and Hell's Canyon will amount to $160,000,000. Work on the Brownlee Dam, now 60 per cent completed on an accelerated construction schedule, will have the first of four generating units on the line by late 1958.

Andover, Mass. — Sylvania-Corning Nuclear Corp has disclosed that it is abandoning plans for development of an atomic center on large building site of 150-acres recently acquired for the purpose, near here. Economic conditions, affecting the entire nuclear industry adversely, was given as the primary cause for this decision. The joint Sylvania-Corning venture was for the purpose of making fuel components for reactors but due to Government cutbacks, peacetime uses which have not developed as predicted and poor overseas markets, plans for further expansion at this time were abandoned. This does not mean that the company as such will discontinue business in this field. Hicksville, L. I. plant has recently been expanded.

Rowe, Mass. — Yankee Atomic Electric Co, Boston, Mass., has announced that company has received permission from the AEC to construct a nuclear electric power reactor on large tract of land here, recently acquired for the purpose. Permit is conditional, pending proofs of company's financial qualifications to build the plant, and on further proof and information as to safety features of the proposed plant. Its cost when completed is estimated at $57,000,000. The pressurized water reactor will be designed to produce 134,000 kw as an initial output.

Ridgefield Park, N. J. — Public Service Electric & Gas Co, 80 Park Pl, Newark, N. J., has announced that preliminary construction work on company's new Bergen Generating Station is well under way. The 119-acre plant site has been raised above flood-tide level by the importation by railroad of more than 850,000 cu yd of fill. Power output will be derived from turbine generators developed by Westinghouse Electric Corp, Pittsburgh, Penna. Each unit will have two shafts turning at 3600 rpm to drive the main boiler pumps directly from the generator shafts. More than an acre and a half will be occupied by the boiler houses and turbine and service rooms. Plant was designed by Alfred E. Poor, New York architect.

Nyack, N. Y. — Creation of a $100,000,000 electric and gas utility in the northern suburbs of New York State will be the direct result of a merger plan announced by the Rockland Light & Power Co, Nyack, N. Y. and Orange & Rockland Electric Co, of Monroe, N. Y. Proposed merger subject to approval of stockholders of both companies and regulatory authorities, would have a service area blanketing Rockland County and parts of Sullivan and Orange Counties in New York and Bergen, Sussex and Passaic Counties, in New Jersey. New utility will be known as the Orange and Rockland Utilities, Inc, and will serve 97,000 electric and 38,000 gas customers. Merger will be arranged through transfer of stock of both companies not yet determined.

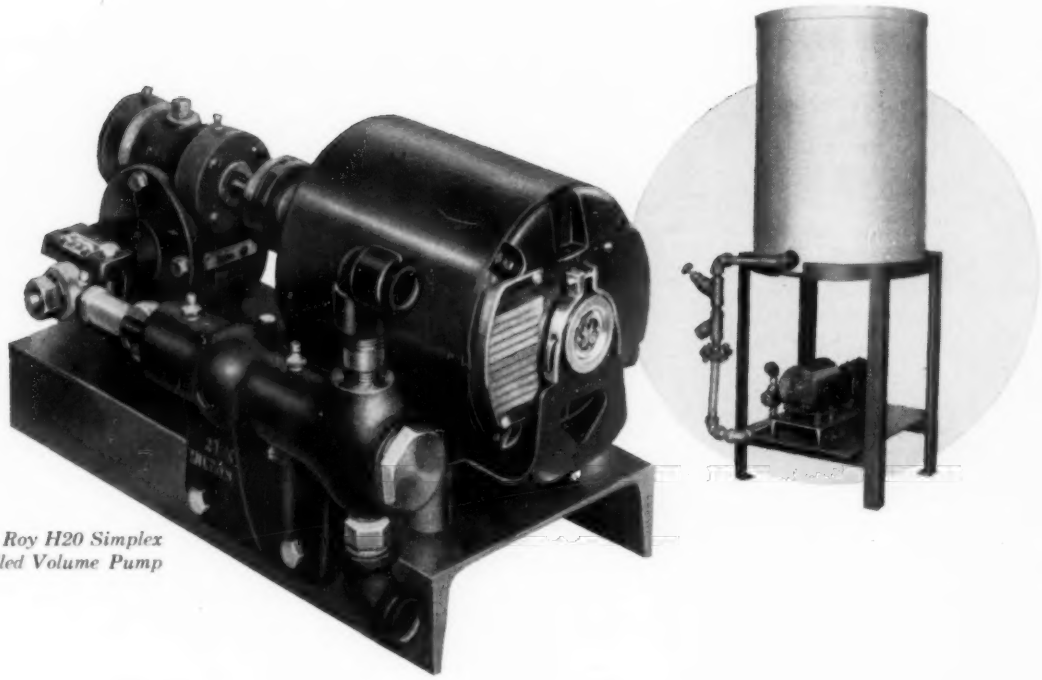
Syracuse, N. Y. — Niagara Mohawk Power Corp, 300 Erie Blvd West, has announced plans for the expenditure of more than $300,000,000, for new facilities in the next three years. To meet the anticipated growth of the area that the utility serves, plans call for the construction of more generating facilities, transmission and distribution lines and any other facility needed for the upstate area which the company serves. Company has recently raised a construction budget of $50,000,000, through bond issue.

Bryan, Tex. — City Council, City of Bryan, in line with approved plans for new additions and improvements to municipal power plant and system, has arranged financing in the form of bond issue of $2,600,000, proceeds of which will be used for this work. These bonds are the second installment of a total authorized issue involving approximately $5,675,000, authorized in May 1956.

Eau Claire, Wis. — Northern States Power Co, 4 S Barstow St, has announced that company has been authorized by the FPC to acquire the facilities of the Wisconsin Hydroelectric Company, Amery, Wis. Wisconsin Hydro facilities used in generating and distributing electricity in nine Wisconsin counties will be liquidated. In the transaction, parent company, Northern States Power Co, Minneapolis, Minn., will receive 58,000 shares of common stock from the Eau Claire concern, its subsidiary, and will issue 176,300 shares of its own stock to Wisconsin Hydroelectric Company. Purchase reported to involve about $6,000,000.

Washington, D. C. — Atomic Energy Commission, 1717 H St NW, has announced the cancellation of plans to negotiate a contract with the Foster Wheeler Corp for construction of a 10,000-kw homogeneous power plant to be operated by Wolverine Electric Coöperative, Grand Rapids, Mich. Foster Wheeler recently withdrew its offer to undertake the Wolverine reactor project at a ceiling price but agreed to proceed on a straight cost basis, fixing the cost of developing and constructing the reactor plant at approximately $14,436,000. The AEC had proposed that the total cost of the project be kept within a budget not to exceed $5,500,000. On this basis, the commission cancelled contract talks with Foster-Wheeler.

Typical packaged system for boiler-water treating ready for shipment includes an H20 simplex pump, a 50-gallon polyethylene tank, suction piping, close-off and relief valves. Standard tanks are available in steel, stainless steel and polyethylene, to hold 50 or 100 gallons. Write for Bulletin 953.



Milton Roy H20 Simplex Controlled Volume Pump

Low-cost Controlled Volume Pumps feed chemicals accurately

High metering accuracy, long service life, minimum maintenance and low cost are the big advantages of Milton Roy H20® Controlled Volume Pumps. They embody quality design features usually found only in higher priced pumps, including: self-aligning bearings . . . self-adjusting packing . . . double ball checks on suction and discharge . . . cartridge-type, easily replaceable valves . . . standard continuous flushing connections.

Both simplex and duplex models are available, and conversion from one to the other can easily be made in the field. H20 pumps can be quickly delivered from stock.

You can depend on H20 pumps to meter boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Write for Bulletin 557 and complete specifications.

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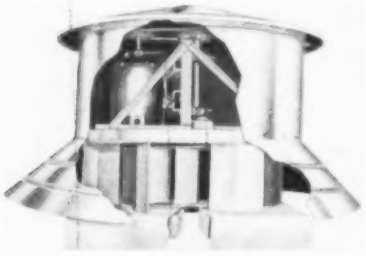
EQUIPMENT NEWS

Reader Service Cards on pages 101–102 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—ROOF EXHAUSTER designed for quiet operation

For applications and installations requiring a minimum of operating noise, the Gyra-Flo Power Roof Exhauster is designed to control the flow of air through the exhauster keeping down turbulence and discharge losses. The wheel of this belt driven unit, which is responsible for the quiet operation, is of the backward curve type, featuring steep pressure curves and non-overloading power characteristics. Constructed of stainless steel or other alloys, these ⅛-in. blades are backed by ¼-in. steel and are statically and dynamically balanced to produce vibrationless operations from 830 to 29,750 cfm. The base,



which supports fan and motor assembly, is constructed of structural angles and heavy steel plates, welded and braced, and rubber vibration eliminators float the base at four points. The reinforced and welded framework can be furnished in aluminum, galvanized iron, copper, stainless steel. Chicago Blower Corp.

3—IMPROVED SEALS resist active solvents, corrosives

Chempac Teflon Clipper Seals are designed for positive sealing in the presence of and in contact with active solvents and corrosives. According to company, the seals have successfully contained oils with varying aniline points that are destructive to many compounds. They are also effective against such widely diverse fluids as rocket engine fuel, perchlorethylene, destructive insecticides, and various refrigerants. The body is made of Teflon and encased in stainless steel or other corrosion resistant alloy. The seal lip is actuated by a stainless alloy spring. The unit is assembled so that all components are in absolute concentricity, manufacturer points out, allowing maximum sealability with minimum lip wear. Recommended shaft finishes for use with these seals range from 4 to 8 microinches. Shaft diameters: springless as small as ⅛ in.; spring loaded ½ in. up. Johns-Manville Corp.

4—800-AMP CIRCUIT BREAKER is heavy duty, molded case unit

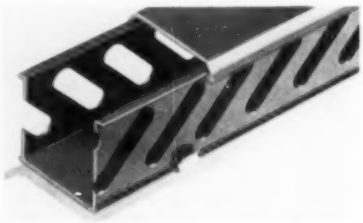
This company has combined its 600-amp L frame and 800-amp M frame circuit breakers and is introducing a new heavy duty 800-amp LM frame with design and construction features previously found in the L and M frame breakers. The new one is UL approved throughout its full current range, manufacturer announces, and from a mounting standpoint it is interchangeable with either the L or M frame circuit breakers previously used. The new LM circuit breakers are supplied with interchangeable trip units with continuous current ratings from 125 amp to 800 amp. NEMA interrupting ratings are 50,000 amp 240 v, 35,000 amp at 480 v, 25,000 amp at 600 v, all a-c; and 20,000 amp at 250 v d-c. The LM may be used as panelboard main breakers, in power panels, switchboards, motor controls, bus duct plugs, and individual enclosures. Pressure connectors are available for single, double, or triple cable connections in each phase. I-T-E Circuit Breaker Co.

5—MOTOR OPERATOR is oil-submerged, proportional type

This oil-submerged, spring return, proportional type electric motor-operator is designed to control dampers in heating, ventilating and air conditioning systems, and in other industrial applications. Mounted in any position, motor features a gear train and drive submerged in oil and sealed in a die-cast. Auxiliary switches are readily accessible and adjustable. The output shaft is power operated in both directions to position a controlled device as required when power is on, company notes, and it maintains this position with an internal holding circuit. Enclosed spring return drives controlled device to its normal position on a power interruption. Motor operator is available in 24, 115, 208 and 230 v. Barber-Colman Co.

6—WIRING DUCT for economical panel wiring

According to manufacturer, Panduit Type C Plastic Wiring Duct reduces control panel wiring installation costs two ways: low initial cost and faster easier maintenance or revision after



wires have been laid. Its design features overlapping closed slots over the full length of the duct. Ready access is possible with a cover which snaps or slides in place, directly on the duct. The cover is removable even when the duct is fully loaded. The duct is made from tough, flexible vinyl plastic and may be cut with a fine tooth saw for fitting at corners and junctions. It can be mounted with spring steel standoff clips, threaded studs or screws. Panduit Co.

7—DUAL RECORDER is designed to save panel space

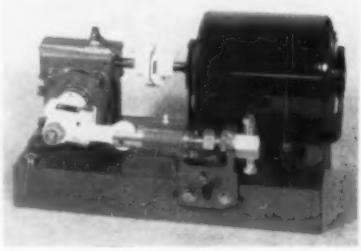
The Twin Recorder consists of two types CH recorder chart carriages and measuring elements in a single case. The 19 by 16⅝ in. flange dimensions allow for mounting on a 19-in. relay rack. Design features include 28 different chart speeds ranging from ¼ in. per hr to 120 in. per min, a large throw-away plastic inkwell, 150-ft long record rolls and extra hand space inside the case to facilitate maintenance. Chart carriages are driven by a single drive motor located in the right-hand carriage. Separate, double-speed drive motors are provided for chart speeds of 30, 60, 90 and 120 in. per min. General Electric Co.

8—PROTECTIVE SEALER for preventive maintenance

Applied to any metal surface that requires protection, Bom-Kote Protective Sealer is claimed to seal out moisture, resist corrosion, acid solutions, salt water and heat, and prevent oxidation. Tests made on machinery, motors,

2—CONTROLLED PUMP VOLUME for metering minute quantities

The miniPump line of controlled volume pumps is designed for flow rates to 7880 milliliters per hr and pressures to 1000 psi. Ruggedly constructed with motor drive action on plunger for suction as well as discharge strokes, this pump has a repetitive accuracy of ±1 per cent of full capacity. Available with column valve type liquid ends constructed of plastic, Milroy stainless steel or Hastelloy C, the industrial miniPumps are described as ideal for accurately metering minute quantities of costly or corrosive fluids, such as perfume into soap, dye into cheese, odorants into gases and hydrazine into boiler feedwater. Driven by ⅓ hp, single phase, 60 cycle, 115-v electric motors, these pumps may have single or duplex liquids ends. Maximum capacities per liquid end range from 300 to 3940 milliliters per hr. Capacities are manually adjustable up to 100 per cent when pump is idle. Milton Roy Co.



CRANE Pressure-Seal Bonnet Valves

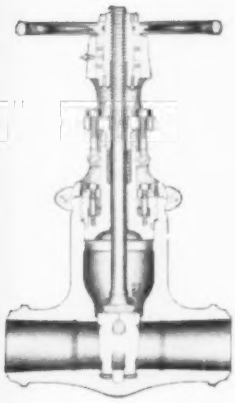
In gate, globe, angle and stop-check patterns—flanged, butt- and socket-welding ends—rated in accordance with A.S.A. in 600-, 900-, 1500- and 2500-pound classes. Sizes: gates—1 to 24 inches; globes and angles—1 to 16 inches; checks—2½ to 12 inches; stop-checks—6 to 12 inches

Crane design is at its very best in this streamlined line of pressure-seal bonnet valves—made expressly for high-pressure/high-temperature service in central stations and industrial power plants.

Bonnet joints in these valves are sealed by a unique method which uses *internal fluid pressure* to effect a leakproof seal. This method virtually eliminates bonnet-joint maintenance—and maintenance costs.

Other features include: weight-saving body design—saving up to 60% over conventional design—swivel action yoke and clamp which permits choice of position for motor or gear mechanism . . . one-piece sealing ring . . . Stellited seating surfaces.

Write to address below for descriptive Circular 1936.



CRANE *high-pressure/temperature valves assure leakproof service–less maintenance*

CRANE Lip-Seal Bonnet Valves

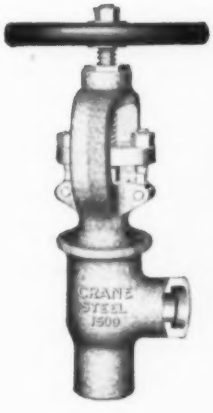
In globe, angle and lift-check patterns; sizes—½ to 2 inches; screwed and socket-welding ends; rated in accordance with A.S.A. in 1500- and 2500-pound pressure classes

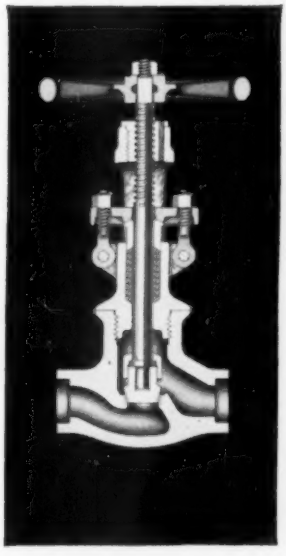
These popular Crane valves are widely used on steam, boiler feed, drips, drains, by-pass, blowdown and similar piping services.

They assure you absolute tightness, no bonnet-joint maintenance, minimum valve weight and bulk without sacrificing strength—and easy, fast dismantling and reassembly.

Features include: lip-seal design which permits re-welding without damage to the valve . . . improved disc-stem connection that minimizes vibration . . . two-piece, non-binding ball-type gland construction . . . and Stellite seating surfaces.

For details, write to Crane Co., for Circular 2099.





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batteries, ignition systems and other metallic surfaces, both painted and unpainted, are reported to indicate effectiveness in preserving appearance also. Bom-Kote will not chip, peel or darken with age, company says, and dries to the touch in 15 to 20 min, setting firmly within three days. It is a non-conductor of electricity. Bom-Kote is formulated for spray or brush-on application. It is available in aerosol cans, and in bulk. The B.O.M. Co.

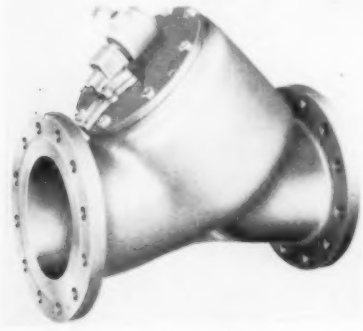
9—TUBE CLEANER designed for quiet operation

Rotojet Electric Tube Cleaner has been developed for tubular equipment in plants where the noise of conventional air-driven tube cleaners is objectionable, or where compressed air or water at high pressure is unavailable. It cleans scale, mud, carbon and other deposits from straight tubes 25/32 in. ID up to 4 in. ID in water tube and fire tube boilers, condensers, evaporators and heat exchangers. The unit consists of a stand-mounted motor, flexible shafting, electric cable, and a selection of cutter heads, brushes, drills, and scrapers to meet specific cleaning requirements. The motor is mounted in a yoke to permit vertical and horizontal movement so that tubes on top, sides and bottom can be cleaned without moving stand. Elliott Co, Div., Carrier Corp.

10—LINE VALVES adaptable for remote control applications

Model 500 Quantrol Shock-Free Valves for 3- to 10-in. water, oil or gas lines, are designed for working pressures to 150 psi, temperatures to 150 F. These valves are reported to be compact, light weight, and easily serviced in the line. They were developed primarily to protect lines, pumps and other equipment against damage from shutoff shock.

Control is by an internal pilot valve which may be actuated by solenoid, hydraulic or air cylinder, or direct manual control. The line valve consists of a



spring loaded valve-piston, seat, and cylinder assembly. The spring holds the valve closed in absence of line pressure, presence of back pressure, or when the pilot valve is turned to allow upstream pressure to flow behind the piston to balance the upstream pressure. When the pilot valve is turned to bleed pressure from behind the valve-piston to the downstream line, upstream pressure against the valve-piston opens the valve. Rate of closing is adjustable by a needle valve on the internal passage. Bulletin 650 gives complete data on Model 500 Valves. Ralph N. Brodie Co.

11—WATER-LEVEL GAGE is readable under all conditions

This steam-boiler water-level gage remains readable under all conditions, cannot explode, and can be harnessed to operate controls automatically, it is announced. For use in power plants and other applications, particularly where steam pressures run in excess of 750 psi, the instrument is similar to conventional

gages in size and shape, but instead of glass or quartz tube, it consists of a non-magnetic stainless-steel pipe enclosing a metal float which carries a powerful permanent magnet. As the float rides up and down on water in tube, the magnet acts through tube walls upon row of metal reeds mounted beside it. Painted white, each reed can be pulled forward by magnet so that it comes into view through a window in front of gage. When float moves again, the reed recedes out of sight. In addition to serving as visible indicators of water level, the reeds can carry electrical contacts which operate automatic water controls or set off alarms. Quick-acting valves at top and bottom of gage serve to disconnect it from boiler if leak develops. Charles Engelhard, Inc.

12—HOT PIPE INSULATION for underground applications

The "b-t-u," an underground hot pipe insulation system, consists of integral waterproofing admixes in combination with specially graded aggregates and portland cement. According to manufacturer, it has high mechanical strength, load-bearing and thermal characteristics, and is extremely resistant to water penetration. It is designed and especially suited for locations with good ground water conditions and firm soil. Z-Crete Div., Zonolite Co.

13—SMOKE INDICATOR for pressurized breechings

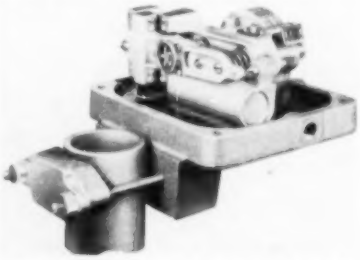
Fireye Smoke Density Indicator System FE-3 is intended to provide continuous monitoring of smoke discharge and overall indication of combustion efficiency. This system is designed for stability, simplicity of installation, and reliable operation — and to help keep smoke discharge within limits of smoke control and air pollution ordinances. The system consists of a light source, photoelectric scanner, and smoke density indicator. Light source and scanner are installed on the stack or breeching so the light beam is aimed at the lens of the scanner. Density of smoke obscuring the light beam is measured and indicated directly on the indicator in both per cent smoke and Ringelmann number. An alarm relay provides for the operation of an external alarm at any present value of smoke density. Combustion Control Div., Electronics Corp. of America.

14—STEAM TRAP features increased accessibility

Improved, simplified construction increases accessibility of Type FT Float-Thermostatic Steam Trap, it is announced. The entire operating element is one unit, which can be removed without disturbing inlet and outlet connection to semi-steel trap body, suitable for 125 psi steam pressure. Operating elements consist of stainless steel valve mechanism, copper float, and bronze thermostatic air vent. Valve is designed to provide condensate seal and prevent loss of steam. It discharges condensate at steam temperature continuously and without shock, company says. Separate air vent, requiring no adjustment when pressure changes, removes all air and incondensable gases, allowing no steam to escape. Manufacturer recommends the trap to drip steam mains, unit heaters, blast coils, heat exchangers, and other allied process applications requiring accurate temperature control. Bulletin 455-B gives details. Sarco Co, Inc.

15—TRANSMITTERS for temperature, pressure measurement

Designated Series 4600 for temperature and Series 4700 for pressure, these transmitters are pneumatic force-balance devices employing gas filled thermal systems for temperature measurement and bellows elements for pressure. An



outstanding feature is said to be their "balanced beam" design which permits mounting in any position without positional error. Unit sub-assembly construction is used throughout, permitting removal of sub-assemblies without disturbing beam assembly. Thermal systems and pressure elements are readily removed for change of range span. A derivative unit, which compensates for lags in the thermal system, can be added on underside of baseplate, and requires no tubing or fittings. There is also a special provision for an integral receiver gage to be mounted directly on baseplate, without external connections. Bulletin 214 gives details. Mason-Neilan, Div., Worthington Corp.

16—HEAVY DUTY PUMPS feature standardized parts

These heavy-duty vertical centrifugal pumps for sump and process service (Figs. 3171-2-3-4) are offered in single and duplex units, both wet and dry type, have capacities to 1080 gpm with heads to 290 ft for pit depths to 20 ft. Their basic design provides users with custom built pumps through usage of standard-

Unretouched photo of tube blister... the result of overheating

...AND THEN THE BLISTER BROKE

This blistered tube was the first sign of trouble in a high-pressure boiler. Accumulation of silica scale deposits on the water side interfered with heat transfer. Overheating caused blistering, subsequent tube failure and inevitable replacement. Proper water treatment can avoid this and other costly conditions such as sludge attachment, return-line corrosion and carry-over.

A Consulting Service for You. Whatever your problems—raw water supply...power plant data...cooling towers, ponds...types of fuel...equipment...test and control methods—Dearborn has the engineers, the experience and the facilities to assist you in developing the program exactly suited to your needs. Your Dearborn representative will outline the many advantages a Dearborn Consulting Service Program will give to you.

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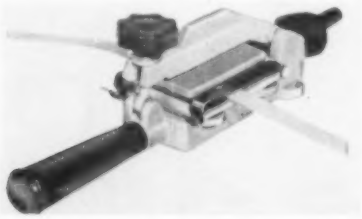
ized parts. The pumping unit may be adapted in the field for changed pit depths or pump ratings simply by installing new and standardized parts. Vapor proof construction can be supplied on all units. In addition, special construction and materials permit these units to handle various types of liquids. Pump assembly, including cover plate, is a complete unit. Liquid level controls can be furnished to start and stop the pumps. Goulds Pumps, Inc.

17—SYNTHETIC BELTING is free of permanent stretch

Texalon, a non-stretch, all-synthetic belting for mechanical power transmission, is a woven nylon textile with a core of extruded nylon. According to company, the flat nylon ribbons making up the



core have been oriented, a process which locks the molecules in position and makes the belt almost entirely free of permanent stretch while retaining its elasticity. Texalon (shown in a press) can be made endless, or purchased to specifications. Nonfraying edges permit cutting to any width, and ease of cementing allows use of short ends. No tension adjustments are required, says manufacturer. Light weight and flexibility permit Texalon's use on small pulleys with high belt speeds and high pulley ratios. In addition to mechanical power transmission, Texalon applications include carrier tapes and conveyor belts. J. E. Rhoads & Sons.

18—VERTICAL PUMP is protected against dirt and water

Type SDV is a general service pump that is installed vertically instead of horizontally to save floor space, and is protected against dirt and water. Available in sizes from 1 to 3 in., with capacities from 10 to 400 gpm at heads of from 15 to 250 ft, the pumps are designed for brine and hot and cold water circulation, air conditioning and sprinkler systems, boiler feeding, pressure boosting and washing machinery. Motor on each pump is carried high above floor level, and thus is unaffected by water or dirt. Pump rotors can be removed without disturbing suction or discharge connections. Rotor assembly is carried on combination thrust and radial ball bearings and encased in a dust-tight housing. Should motor fail, it can be replaced with any ball bearing motor of similar frame, power. Economy Pump Div., C. H. Wheeler Mfg. Co.

19—FAULT LOCATOR quickly finds the power failure

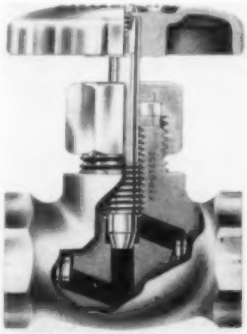
According to company, this outage locator finds faults without subscriber participation and saves time and manpower on service restoration calls. It is an FM transmitter operated automatically in response to a tripped associated recloser, fuse or circuit breaker. Each sectionalizer, equipped with an outage locator, transmits a distinctive coded signal which identifies that sectionalizer. This coded information is received directly by mobile unit or base station, providing maintenance department with immediate notification of line failure. Coded signal is sustained only for short time periods to avoid confusion of signals transmitted by other locators which may be tripped at same time. Normal range is 35 miles when unit is mounted at an elevation of 35 ft on a pole. Unit operates on 105 to 125 v, 60 cycles and has a power consumption of 15 to 50 w. Motrel, Inc.

20—REPAIR MATERIAL is wear-resistant, self-lubricating

Devcon WR is claimed to outwear steel 60 to one. Successful use of this wear-resistant and self-lubricating material is reported in such applications as guides on textile machinery, low speed bearings, building up surfaces subject to severe wear, and forming dies. Because of its resistance to many acids, alkalies, solvents and other chemicals, it is said to be of great value for lining tanks and repairing chemical equipment. Devcon WR is supplied in paste form and upon the addition of a hardening agent, it becomes a syrupy liquid which can be cast or poured into a variety of shapes. Manufacturer states that within 2 hr after addition of hardening agent, the material becomes so tough and rigid that it cannot be machined except with carbide or similar tools. No heat or pressure is required for hardening, and the shrinkage of a 4-by-3-by-1 in. block, for example, is said to be only 0.0002 in. Devcon is supplied in 1-, 4- and 15-lb containers with proper amount of hardener required, sufficient release agent, measuring spoons and directions. A trial kit containing four 1-lb cans and components costs less than $12.00. Devcon Corp.

21—NEEDLE VALVE for use as gage, or for metering

Designated Type N-28, this globe type needle valve is for use as a gage or for metering service in gas, oil, water lines or other similar uses. It has been devel-

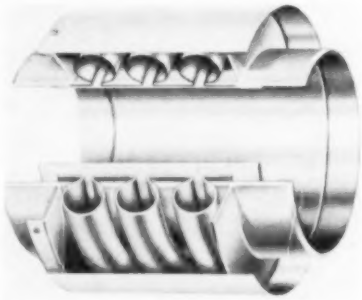


oped for applications where space is a factor and where operating areas are close. The valve features a one-piece solid forged carbon steel stem with Teflon packing. Short, compact and precision machined, this valve is available in four sizes from ⅛ to ½ in. It has a maximum working pressure of 10,000 lb psi at 70 F, and a maximum operating temperature of 500 F. Kerotest Mfg. Co.

Described on these pages are new and improved products. Use Reader Service Cards on pages 101–102 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

22—EXPANSION JOINTS with toroidal corrugations

For high pressure and high temperature service, HyPTor Expansion Joints embody a patented toroidal corrugation design. They are intended to protect power and process piping systems and related equipment against damage from expansion and contraction due to temperature. These expansion joints are



formed by a hydraulic technique, eliminating circumferential welds. Toroidal corrugations have circular or oval cross sections which, for any given pressure, produce operating stresses lower than other corrugation shapes, manufacturer explains, and the thin-walled bellows of the HyPTor design reduces flexing stresses and increases expansion joint life. The new expansion joints are usually made from stainless steel in 6-in. diam sizes and larger, for pressures to 2000 psi. Zallea Brothers.

23—THERMOMETER shows temperatures of remote points

This electronic resistance thermometer is designed to indicate on its meter, at one central location, temperature of remotely located check points throughout a building's heating and air conditioning system. This is accomplished through wire resistance elements remotely located and connected to a corresponding switch on a central panel. Thermometer consists of an indicating meter, a bridge and power supply and as many sensing elements and selector switches as are necessary to remotely check temperatures at all control points required for each application. The four types of sensing elements available are room, duct, immersion and outdoor. Thermometer is adapted to either cabinet or panel mounting, depending on types of application. Details are in Data Sheet F 8081. Barber-Colman Co.

24—BUS DUCTS offer several design improvements

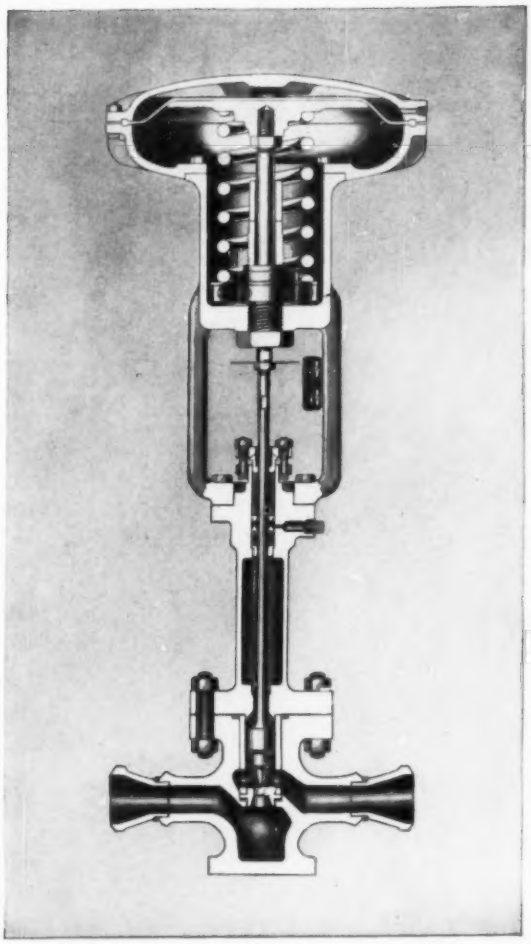
Improved design low impedance feeder and plug-in bus ducts are supplied with totally enclosed, ventilated or weather-

This advertisement is a round-up of recent advances in utility control valves.

How do you design control valves for high pressure — temperature services about which little is known?

Leslie engineers faced this problem when asked to develop control valves that would allow utilities to cross the threshold into Btu-saving, high pressure — temperature steam generation.

Tomorrow's utility control valves today



The Leslie Class DLHS-2 Diaphragm Control Valve has shown remarkable resistance to erosion in high pressure, high temperature service.

Called upon to develop control valves with maximum resistance to erosion and corrosion in high pressure, high temperature steam and boiler feedwater services, Leslie engineers had two factors in their favor—a 50-year tradition of introducing new ideas in steam controls and the ability to get to the root of a problem fast, and objectively.

What Resulted

Not only have valves with remarkable resistance to erosion been put into service but they were the first valves ever introduced for services as high as 2500 psi, 1050 F with renewable trim that can be completely changed in 15 minutes downtime!

Leslie pioneered new uses of hard facing alloys for high pressure, high temperature control valves, just as it pioneered the use of stellite in normal pressure ranges over 20 years ago, when it became the standard seating surface for all Leslie steam regulators and control valves.

Companion Developments

Companion developments for tomorrow's high pressure and temperature control valves include the industry's first large size, fully balanced, single seated control valve, in sizes up to 16 inches; its first self-contained regulator to act as a combination pressure reducing and remotely operated shut-off valve in soot blower service, and the industry's first remote manual valve for centralized control of start-up drains.

For the "Day After Tomorrow"

A startling new concept in high pressure control valves—one that offers increased rangeability and throttling action with tight shut-off is now being made ready for field tests in high pressure applications. Other designs incorporate a new "protected seat" feature for maximum erosion resistance under extreme pressures and flashing mixtures.

These advances also reflect the kind of engineering incorporated in the broad line of standard Leslie control valves suited for many normal-pressure, utility services. But more important, we like to think that these advances justify the faith placed in Leslie Co. by the power industry in providing new opportunities and challenges to design and produce controls for the applications of tomorrow's steam generating stations.

Three Special Data Sheets Available

The following Engineering Data Sheets are available on request from Leslie Co., 301 Grant Avenue, Lyndhurst, New Jersey:

- Selection of Control Valve Body and Trim Material for Flashing Mixtures.
- Flow of Flashing Mixtures, Globe type Bodies.
- Viscosity Correction for Sizing Control Valves.

657

LESLIE®

REGULATORS AND CONTROLLERS

LESLIE CO., 301 GRANT AVENUE, LYNDHURST, N. J.

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THE DRY FLUID DRIVE
100% efficiency at full load!

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Cost less—deliver more!

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- Torque-Arm Speed Reducers. 15 sizes—1 to 100 hp. Bulletin A-637.
- Roller Bearings. Load ratings, dimensions, etc. Bulletin A-638.

Write for your copies.
DODGE MANUFACTURING CORPORATION
6400 Union Street • Mishawaka, Indiana

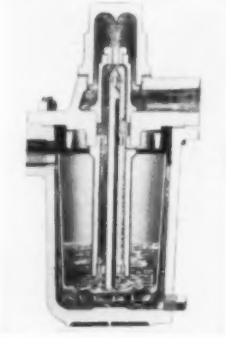
DODGE
of Mishawaka, Ind.

For more data circle 528 on Post Card

proof housings. Design of the new bus ducts permit assembly of tees and elbows during installation to meet particular plant needs. Self-supporting busbars are secured in place on 11-in. centers by means of phenolic blocks. Bus bars are arranged with integral plug-nuts at one end and slotted holes at the other to simplify alignment and bolting. Extra slotted holes and plug nuts are provided at each joint to facilitate on-location assembly of tee at the splice between standard 10-ft duct sections. It is noted that heavy current take-off devices can be bolted on bus at any time without disturbing splice between installed sections. Three sides of the housings are welded to provide strength, and covers are bolted for accessibility to bus assembly. Announced as UL listed and meeting NEMA standards, this bus duct is made available in nine ratings ranging from 600 to 4000 amp. Federal Pacific Electric Co.

25—STEAM TRAPS have rotating valve feature

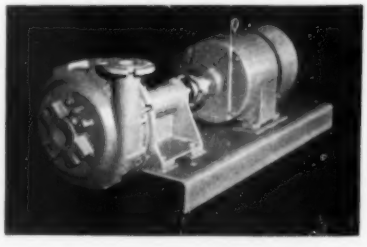
An impeller-driven rotating valve is a feature of these steam traps. Valve assembly comprises bucket, valve and impeller operating as an integral unit,



and is the only moving part in the trap. Impeller changes seating position of valve at every discharge; prevents uneven wear of valve and orifice, wire-drawing and costly steam leakage. Impeller action also keeps sediment agitated so that it passes out with each discharge of condensate. Low cost preventive maintenance is made possible by a convenient removable cap, permitting inspection of valve and seat without disturbing high-pressure bolts or gasket. A bulletin giving engineering data on the traps is offered. H. O. Trerice Co.

26—SLURRY PUMP offers abrasion resistance, high speed

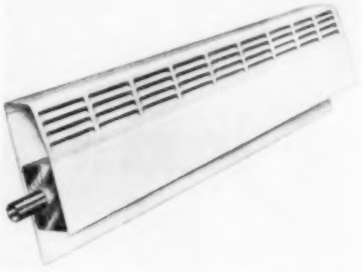
Type BA is a medium-range, high speed slurry pump designed for handling suspensions of sand, coal, crystals, silt, sludge, lime or chemical process slurries. The pump, which is an extension of



company's line of heavy duty, low speed pumps, is especially designed for pulp and paper, chemical, or other industries where both abrasion resistance and high speed are desired. Built in 1- to 4-in. sizes, the BA is available in cast iron, Ni-hard or stainless steel. Easy to dismantle and re-assemble, pump features a renewable suction liner and semi-open impeller. Bulletin 188 gives further details and drawings of the Type BA Pump. Morris Machine Works.

27—BASEBOARD assembles by snapping parts together

Designed primarily for commercial and industrial installations using hot water or steam, the BFOT Baseboard can be



assembled by "snapping" components together. Other features include easy cleaning without removing cover, improved circulation of cold air from windows without heat loss, low first cost and lower installation cost. Baseboard has heavy gage steel cover, angular louver grilles, heating elements in steel tube and steel fin and copper tube and aluminum fin designs for medium and high output applications. Lever-operated or knob-operated damper is optional. Dunham-Bush, Inc.

28—CONTROL VALVE for gases, liquids in high pressure drop

Type 505 is a high pressure control valve specially designed to handle gases and liquids in high pressure drop, on-off or throttling service, with dead-end shutoff. The split body construction valve has a pressure and temperature

rating of 10,000 psi at −40 to 400 F. It is available with a direct or reverse action actuator with standard 3–15 and 6–30 psi instrument air range. Body is forged stainless steel with hardened steel trim. Connection sizes are ½ and ¾ in. NPT. Connections for high pressure tubing are included. A. W. Cash Co.

NO REBORING—

NO KEYSEATING—

NO MACHINING—

NO WAITING!

TAPER-LOCK SPROCKETS
SINGLE AND DOUBLE STRAND!

NOW Taper-Lock *Double* Strand Sprockets are available—from stock—ready for the shaft without re-machining!

They offer all the advantages of Taper-Lock mounting. Easy on! Easy off! Precision machined at the factory, they come to you with accurate, concentric bores—insuring full contact between hub and shaft. Taper-Lock grips with the firmness of a shrunk-on fit!

There is no flange, no collar, no protruding part. Flush design means *safety*... If the sprocket becomes worn, you replace only the tooth part. The bushing is used again and again. And Taper-Lock bushings are interchangeable in Dodge Taper-Lock Sheaves, Couplings and Conveyor Pulleys!

Taper-Lock Sprockets and Dodge Roller Chain (made to ASA standards) are stocked by Dodge distributors. Single Strand sizes range from No. 40 to No. 160, up to 112 teeth; Double Strand from No. 40-2 to 80-2, up to 102 teeth. Write for Bulletin A-644 containing selection, installation and maintenance data.

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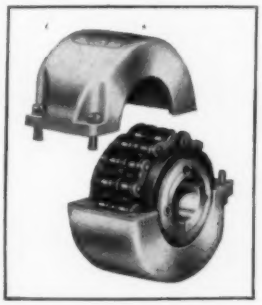
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new methods. Look for his name under "Power Transmission Machinery" in your classified phone book, or write us.



TAPER-LOCK CHAIN COUPLINGS

Accommodates common minor shaft misalignments. Provides strong, compact coupling. Available with covers, for appearance, safety, dirt protection and lubrication—which increases coupling life.

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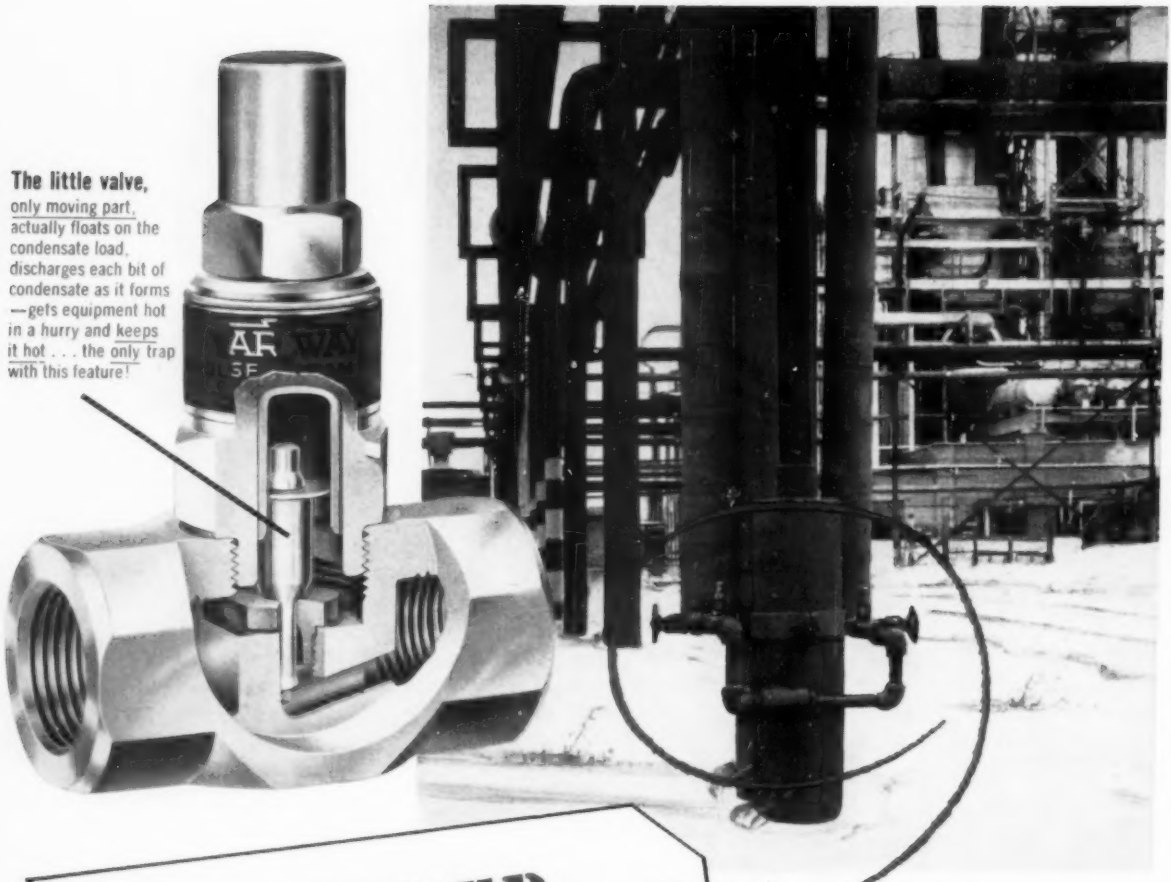

PREPARED FOR WINTER!

Is your plant ready for cold weather?

Steam lines and process equipment equipped with Yarway Impulse Steam Traps *are* prepared for winter:

. . . protected against freeze-ups.

. . . capable of operating at high even temperatures.

. . . ready for peak production loads.

The little valve of the Yarway Impulse Steam Trap (only moving part) continually tests for condensate, discharges each bit as it forms, prevents freezing.

Combined with other important Yarway features—fast equipment heat-up, stainless steel construction, small size, light weight, good for all pressures without adjustment, low initial cost—this adds up to *the best winter trapping you can buy.*

Check your traps now. Then call the Yarway distributor for the Impulse Traps you need. 270 of these distributors, one near you. We'll gladly send you his name also the latest Yarway Steam Trap Bulletin. Write to . . .

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY

impulse® steam trap

The Impulse that revolutionized steam trapping 20 years ago.

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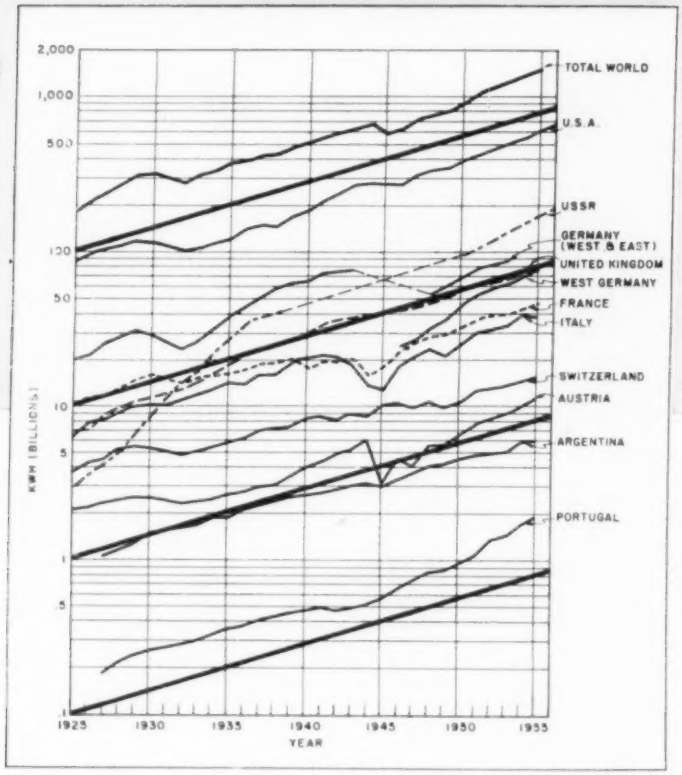


PARALLELS OF POWER

Growth in Production of Electric Energy in Various Countries and the World (Chart, courtesy Philip Sporn)

THIS chart showing the growth in the use and production of electrical energy in the various countries of the world is startling in its implications. Note the general pattern—the lines are parallel. Whether it be Portugal, a tiny nation on the edge of Europe, or Argentina in the Southern hemisphere, or the United States, producing 42 per cent of the world's electricity, or enigmatic Russia with its vast water power reserves, the growth curves are similar; all slope upward at the same angle. The rate at which electric power use is growing is essentially the same in all countries; it is doubling approximately every ten years. If we include all power use, not only electricity, the estimated world total comes to an energy equivalent of some 25 trillion kwh—roughly 10 tons of coal for every man, woman, and child of the world's present population. By 1975, it is estimated, the demand for power will be three times this amount, and by the end of this century it will be around eight times as much.

Where is all this power coming from? What factors are involved in this continuing increase in power use, and how can we hope to meet these stupendous energy requirements in the years ahead? How does population growth influence power growth and vice versa? What new sources of energy can we hope to tap as our present reserves dwindle?

These are pertinent questions. Our whole future depends upon how well we understand them and what we do about them. Many factors are involved but one thing is becoming increasingly clear; the need for basic research is paramount, and it is to this aspect of the situation that we devote the following pages. In the articles that make up this special section we discuss the importance of science and research in meeting the world's future energy requirements. The launching of the two Russian satellites lend emphasis to this discussion. At the moment the Russians hold the field in this endeavor; their immense technical competence has thrown the whole question of basic research into new and startling perspective, one affecting our very survival. The same emphasis on fundamental research which enabled Soviet scientists and engineers to build and launch their Sputniks will enable us to develop methods and materials, not only to harness the virtually inexhaustible reserves of energy in the atom but also to meet the increasing complexities and requirements of future power transmission and distribution systems.

Andrew C. Kramer

Scientific Progress and World

Growth of energy production continues at about the same rate in all the industrialized countries of the world, doubling approximately every ten years. Many underdeveloped countries, however, need capital and technical assistance from the industrialized nations. Continued population growth presents big problems for the future

DESPITE THE GREAT strides which the industrialized nations have made in the fields of science and technology during the last century, one of the gravest problems facing the world today is the effective use of this science to further the production and application of energy, not only in underdeveloped countries where energy production is low but also in the industrialized nations faced with ever increasing population growth. Since the industrial revolution it has become increasingly clear that the economic welfare of any country is directly related to the energy production of that country. Countries with low energy production are characterized by economic stagnation due to low productivity of labor.

We, in the United States, find ourselves in a very favorable position with respect to the development and use of energy. We were endowed with enormously varied and abundant natural resources; vast deposits of coal, oil, and gas, extensive mineral deposits and great areas of land favorable to agriculture. These are our basic natural resources. Our less tangible assets are integrity, energy, ingenuity, scientific knowledge, technical know-how, and that ability to get along together in what we call good human relations. With these combined assets we have carried industrialization further in America than in any other part of the world.

But the time has come when we can no longer expect to stand alone in this respect. All the nations are growing up; most of them are demanding a share in the world's comforts and unless we are willing to help them our own well-being cannot remain assured.

Contemporary growth of energy resources and production has transcended national boundaries, and this provides the strong industrialized nations with two alternatives: they can try to use their material advantage to perpetuate the gap between themselves and the underdeveloped countries, with eventual catastrophic consequences, or the industrialized nations can use their efforts to establish coöperation among all nations for the development and use of their material resources. Not only will the latter course speed up development of those resources but it will also help to eliminate some of the causes of present international tensions. Just as we endeavor to lead the way in constitutional democratic government so also can we lead the people in underdeveloped countries to a better way of life and to higher standards of comfort by assisting them to develop their natural resources. In all this, science and engineering will play the dominent role and the electric power industry will be the medium through which most of it will find expression.

Energy and Population

No consideration of future world power development would be of much value unless it took into account the world's growing population. Population growth and energy development are interrelated. In the period before the industrial revolution, population increase was limited by the available food supply, and in the absence of mechanical power, this remained small. Recurrent famines kept population levels under control. The development of mechanized agricultural machinery, however, coupled with advances in medical science, has removed the former curbs on population growth, with the result that there has been a virtual population explosion throughout almost the entire world including the United States.

In the industrialized nations population growth provides the mainstay of the continued expanding economy. In the U. S., even at the present time with the low level of family formations resulting from the baby drought of the depression years, our increase in population amounts to 2,900,000

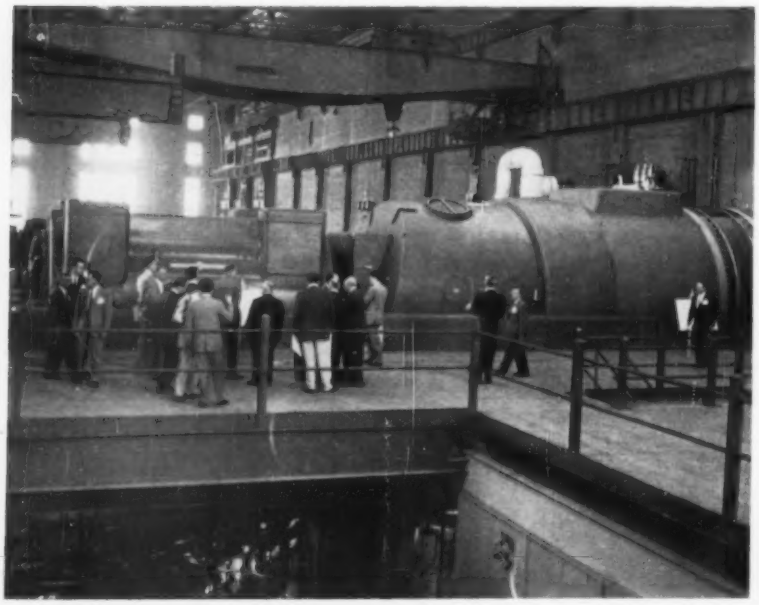
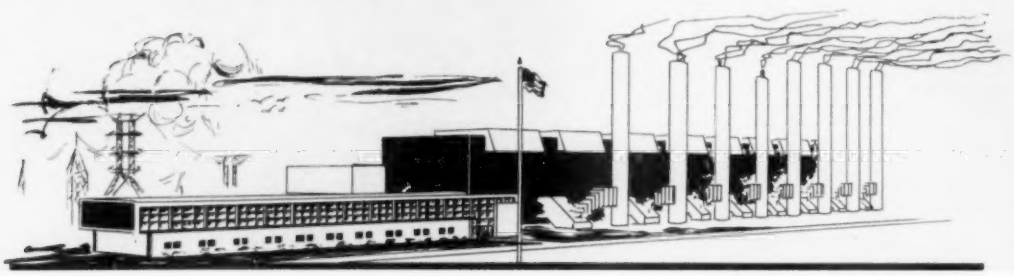


Fig. 1. The world's first supercritical turbine generating unit went into service at Philo Station of the Ohio Power Co during the year. Rated at 125,000 kw, it operates at 4500 psi, 1150 F, and with a heat rate of 8530 Btu per kwh

Power Development



persons a year. This rate is far above the average annual increase of 1,600,000 which held during the years of the first half of this century. However, as a result of the great number of children born in the years immediately following World War II, the population growth during the 1960's will be even much greater; indeed, by the late 1960's our population will increase at a rate of over 3,500,000 a year. By 1970 the population of the U. S. is expected to go to 212 million, an increase of more than 26 per cent over that of 1956.

From the standpoint of industrial production and our expanding economy the increase in birth rate and population in the United States is generally regarded as a favorable factor because our standard of living and our earning power is such as to make the necessary investment in plant possible. This, however, is not true in the underdeveloped countries. There, the continued increase in population becomes a matter of grave concern because such countries do not have the money and trained manpower to develop the limited resources they may have.

It is frequently suggested that nuclear power can be introduced in the underdeveloped countries to raise their economic status but it seems unwise to press such countries into seriously considering nuclear power at this time when the application of their limited resources toward more attainable goals would serve greater advantage and, at the same time, would allow them to await the development of more economic generation of nuclear power. It is unlikely that countries with little capital and low productivity will be able to take a sudden step forward with the coming of atomic energy. The first need is to help improve agriculture and health; the next, to train technicians and scientists able eventually to develop industry, including atomic energy.

The Rising Tide of Energy

Man's early progress was very slow. Through untold centuries he eked out a bare existence by virtue of his own muscular power. Later he used beasts of burden, and in time he learned to use the power of the wind and of falling water with primitive windmills and water wheels. The real breakthrough, however, came with James Watt's invention of the first practical steam engine. The power of steam, harnessed by Watt started the industrial revolution and set the pattern for the industrialized world as we know it today. With each advance in technology, the number of people that could be supported per

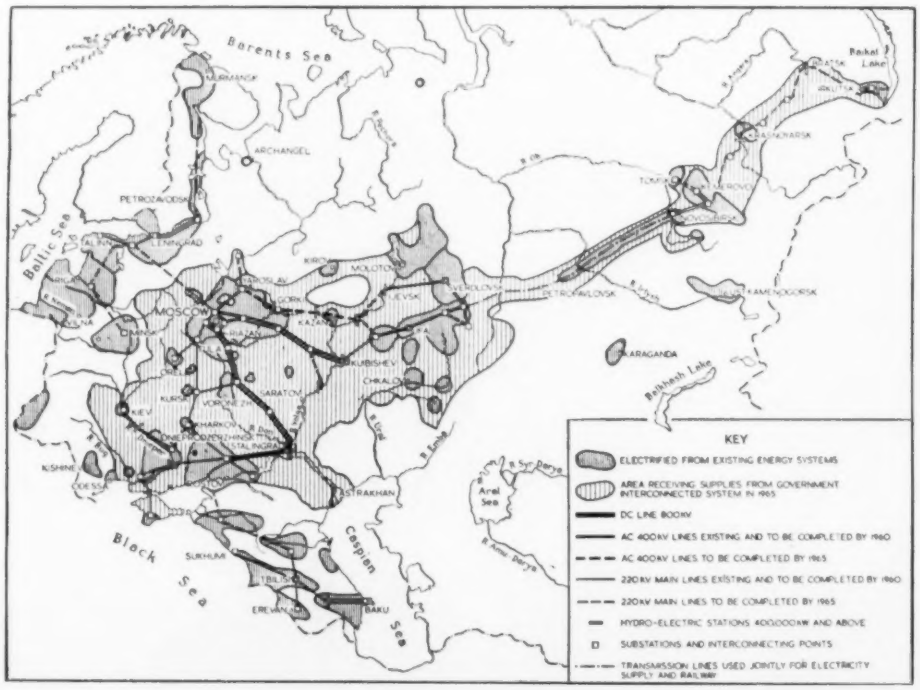


Fig. 2. Map of the Soviet Union showing areas of public electricity supply with inter-connecting power transmission systems

Figs. 3 and 4. The new look in system operation. These relay racks in the Huntley Station of the Niagara Mohawk Power Corp are the heart of the automatic system control system designed by Minneapolis-Honeywell. The view at the right shows a robot electronic translater

acre or per man-hour of effort increased substantially.

The steam engine and later other types of heat engines provided a source of constant, concentrated power that was dependable as long as a source of fuel was available. Fortunately, first wood, then coal, oil, and gas were readily available to turn the wheels of the world and the industrial revolution spread over the face of the entire western world. We increased our numbers tremendously and have developed an irresistible urge for an ever increasing standard of living. These are social forces which cannot be denied but they bring new and serious problems. Unless we can tap sufficiently large reservoirs of energy to satisfy the continuing and rising demands, our civilization as we know it today is destined to suffer severe disturbances.

Looking back to Watt's time, 1769 — less than 200 years ago, the world population was about three-quarters of a billion. Today, it stands at two and one-half billion and the rate at which it is increasing is all but astronomical. So rapidly has our growth been in recent generations that of all the people who have existed on earth since the beginning of the human race, *one out of 15 is alive, eating, and propagating today!*

The relation between the use of power and population growth is a closed cycle. As we use more power for industrial purposes we can support more people. This leads to more industrialization, which leads to increased standards of living, which require more power. It is a chain reaction which is now beginning to be felt and which will impose ever increasing problems for future generations. With only 7 per cent of the world's population, the United States owns 50 per cent of its wealth. We produce over 42 per cent of the world's electrical output. High industrial production requires large quantities of raw material as well as abundant energy. If the world as a whole should reach the same level of industrial production as we now have in the United States, it would need an increase of over 700 per cent in the use of energy as well as a comparable increase in minerals, and other natural resources.

The explosive increase in the population of the world which is now well started will not stop in the foreseeable future. There is virtually nothing we can do to stop it. Predictions can be made quite accurately for at least three generations, just a bare hundred years and the results are disquieting. At the moment we have a population of 165,000,000 in the United States. Within the life span of the children now being born, the population of the United States will be at least 375 million — even if the rate of increase at that time has dropped to zero, and there is no reason to believe that this will be so.

Considering the world as a whole, in the next century the two and one-half billion population we now have will almost inevitably increase to six billion and it may be as high as eight billion. As pointed out in a recent book, "The Next Hundred Years" by Brown, Bonner, and Weir, we are on a runaway train headed toward a world population by the year 2050 of at least 7 billion persons and, if it goes much beyond that, headed irre-

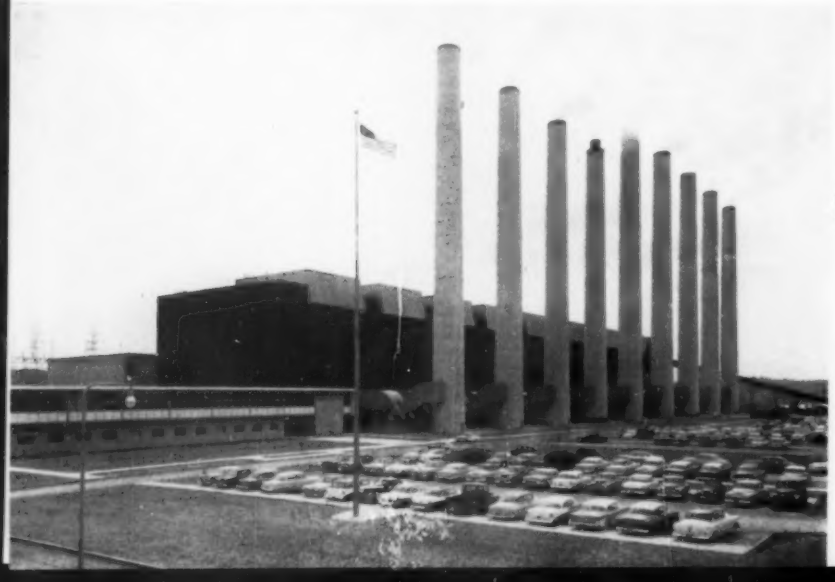


Fig. 5. The Kingston Steam Plant. This TVA plant with nine generating units with a combined rating of 1,440,000 kw and a capability of 1,600,000 kw is the largest steam plant in the U. S.

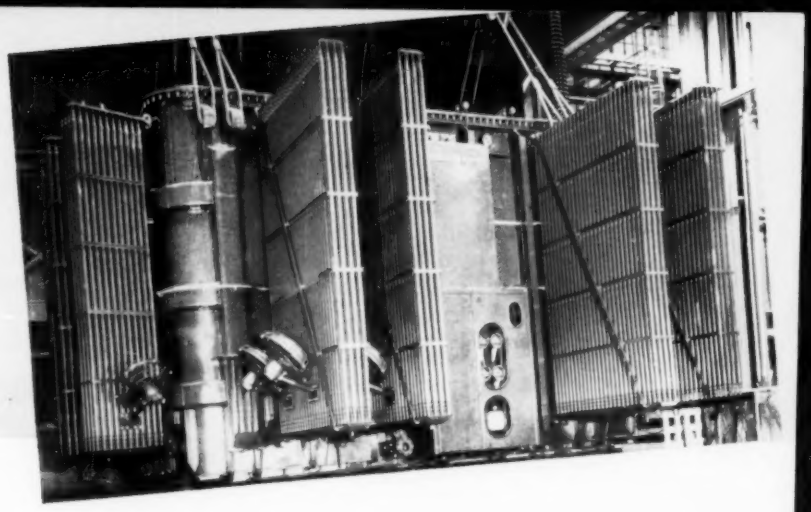


Fig. 6. This huge autotransformer, one of six built by G-E for the Bonneville Power Administration, is rated at 200,000 kw. This unit is typical of the high-capacity equipment which is needed to meet our ever-increasing power load

versibly, as C. G. Darwin has emphasized, toward a progressive Indianization of the whole world into crowded, starving continuous villages, unless we can find and apply enough energy. It will be utterly impossible to support this number of people unless we have a very high degree of industrialization throughout the world. The old pattern of subsistence agriculture, which held in America 200 years ago, and which still holds throughout a large portion of the world, simply will not do.

To provide the industrial pattern to support this enormous world population the first requisite is the availability of an adequate amount of energy to supply the power for the innumerable machines, vehicles, space heating, chemical processing and metallurgical work plus other functions not yet dreamed of. Actually, as congestion increases, the amount of power needed rises much more sharply than the number of people who use it. At the very minimum, it is reasonable to assume that a century from now the world will require at least 50 times as much energy as it is using today; some estimates are far higher.

Until very recently it was quite unpopular to express concern about the world's future energy supplies; only a few academicians did any worrying about it. It was generally assumed that coal deposits were virtually unlimited and that oil reserves would continue to be discovered almost without end. But now even hard-boiled industrialists are beginning to be concerned and the almost unlimited fuel reserves that were supposed to exist now, suddenly, seem to have vanished. Though we still have ample coal and oil in the ground and are still finding new deposits, it is becoming evident that the cream has been skimmed off, and that the whole bottle of milk may disappear quite rapidly. The Suez crisis served to show how vulnerable certain of our fuel supplies are, how dependent they are upon political events, and how necessary it is to have access to sources close to home.

So the time has come for us to begin to become constructively worried about the future energy sources. During the past few years a considerable amount of thought has been given to various possible sources, particularly to the use of solar energy. Despite all the effort spent in trying to devise methods for utilizing solar energy very little progress has been made. The trouble with solar energy is that it is too dispersed, and comes to us too intermittently. Some success has been made in developing solar heaters for heating houses and for heating water and these developments may find application in certain backward countries where fuel for domestic use is practically non-existent, in many parts of India for example.

Secondary sources of solar power such as windmills, and wave motors have been tried but without particular success. The only secondary source of solar energy that has proved of significant value is water power. Hydroelectric power is an indirect use of solar energy and, of course, great use of it has been made in various countries of the world. Where available it is the least expensive source of electric power. Unfortunately in America only about one per cent of our energy is supplied by hydroelectric power. Even if we stretch every resource where a reasonable head could be obtained, we might double this amount, but the proportion will always remain small.

Various other schemes are being studied — thermocouples, photovoltaic cells, biological growth, artificial photosynthesis, and the large-scale distillation of sea water, but it appears doubtful that any of these schemes will provide industrialized nations with the energy they will need in the future. While several of these ideas offer interesting possibilities for limited uses of solar energy none of them represents a panacea for the future energy demands of the world. This should not discourage workers in this field. Hundreds of millions of people live in areas of the world where there is abundant sunshine and where the technological level of society is low and where other forms of power are either non-existent or very expensive. A solar house heating system in such areas would represent a great advance in the standard of living for many. Solar reflecting ovens would be useful in many underdeveloped countries and if a fairly efficient solar sea water distillation plant could be devised, it would help greatly in relieving the almost desperate fresh water shortage in many arid regions along the seacoast.

But as far as America and other highly industrialized nations are concerned it is quite unlikely that solar energy will ever be an important factor in the total amount of energy used. We use too many power-hungry machines that require a continuous, concentrated supply of energy. Thus far, the fossil fuels have supplied the ever increasing needs for energy and they will continue to do so for some decades to come. But after they are gone, we will need new sources if our industrial civilization is to prevail.

There is really only one way we can turn in meeting this problem — to atomic energy. In the uranium reserves of the world we possess a far greater quantity of potential energy than in all the fossil fuels in the world. The known reserves of uranium and thorium hold enough energy to serve the world, even with the anticipated rise in energy use, for several hundreds of years to come — and perhaps even longer.

We already know how to use the fission of uranium and thorium to produce electric power. True, many technical and economic problems remain to be cleared away but nobody who believes in the scientific method will doubt that all these problems will be solved. The next big step in the use of nuclear energy, however, will be the production of power from a controlled thermonuclear reaction. Here, the scientific and technical difficulties are enormous but work is proceeding in this field in several areas of the world, and those who are working in this fascinating field are all optimistic as to the ultimate success of their work. THE END

1947-1957, The First Decade of

While the first ten years of nuclear power development have demonstrated the technical feasibility of producing electricity from nuclear energy, the economics of the process still present difficulties and uncertainties. Much work is in progress, however, and as experience is gained methods of reducing costs will no doubt be found.

By ANDREW W. KRAMER

THE HISTORY OF MAN has been marked by several periods when some great discovery or invention produced a revolution in our way of living. The discovery of the metallurgy of bronze and iron resulted in changes of this character, and in the 18th and 19th centuries the harnessing of the energy of coal with the steam engine led inevitably to the industrial revolution.

Now, we are in the early stages of another revolutionary change — the harnessing of the energy of the atomic nucleus to serve man's needs or perhaps to destroy him. This revolution may transcend all earlier ones because of the enormous increase in the force now available to man. In the fission of uranium we have a source of energy so concentrated that it staggers the imagination. When we consider that a quarter of a cubic inch of uranium-235 — a particle the size of a pea — can produce as much energy as 6 million cu ft of gas, as 7000 cu ft of oil, or 5000 cu ft of coal — then we get some idea of the stupendous force locked up in the nucleus of the atom.

Although the scientific history of atomic energy goes back to the discovery of radioactivity by Becquerel in 1896, the period of what might be called practical use of atomic energy began shortly after 1940 when the idea of the atomic bomb was conceived. This period can be divided into three stages, the first of which, of course, involved the war years which gave birth to the atomic bomb. This stage was marked by complete government management and control.

The second stage comprised the post-war years, during which the Atomic Energy Commission struggled to nurture an infant industry while giving first attention to the production of nuclear weapons to meet the threats of cold and hot wars. This period was also marked by a partial relaxing of government monopoly as expressed in the Atomic Energy Act of 1954.

Now, we are in the third stage — the period of rapid growth, wherein industry is learning to appreciate the opportunities and headaches that accompany participation in the development of atomic power under continuing government regulation. While the Atomic Energy Act of 1954 removed a number of the government restrictions which had been imposed by the McMahon Act of 1946, the Atomic Energy Commission still exercises widespread control over commercial organizations working in the nuclear field. It controls the source of fissionable materials, it regulates licensing and imposes restrictions concerning the scope of patents. Nevertheless, the new act is a step in the right direction; it gives industry freedom to enter the atomic business on its own account, but not completely as a free agent. In time, as the industry grows and begins to find its way, many of the restrictions which now seem necessary will no doubt be removed or modified.

In the meantime, one of the encouraging aspects of the present phase of atomic energy development is the almost complete removal of secrecy from the areas of nuclear information of value to industry in the peaceful uses of atomic energy. It is only five years since the AEC released the first declassified report on

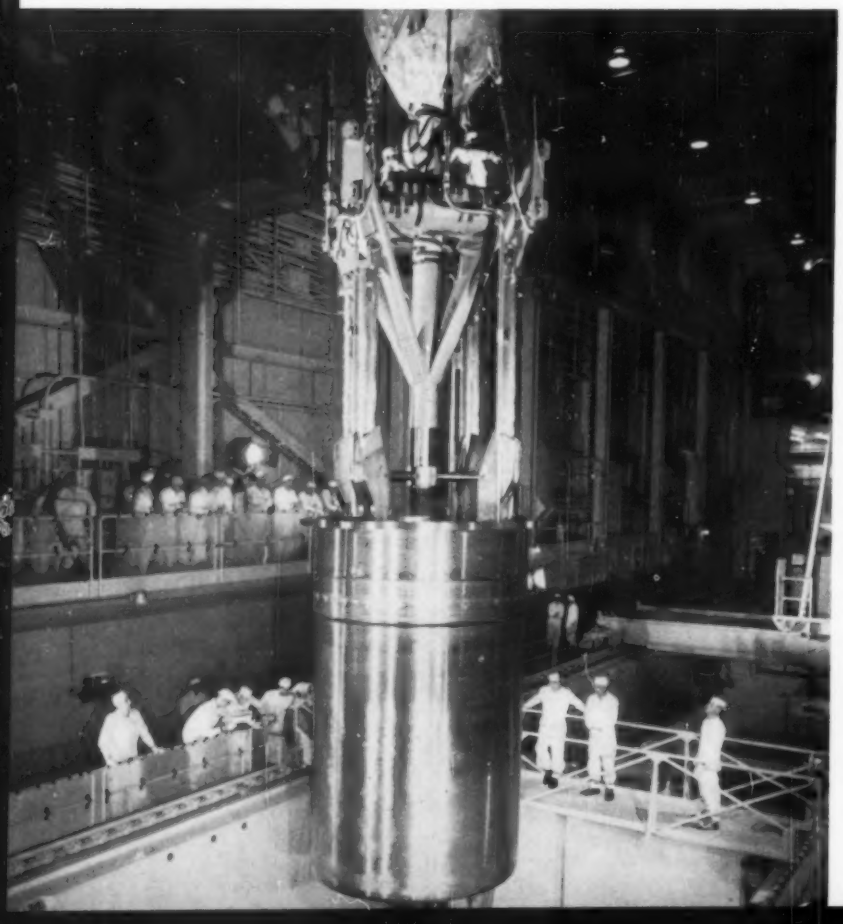
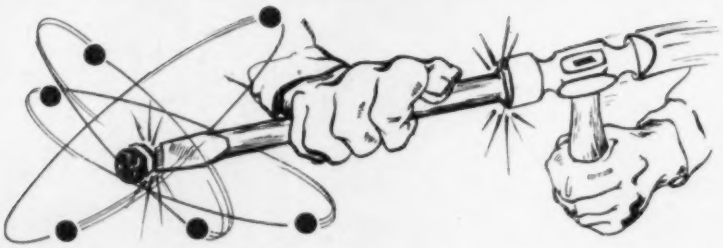


Fig. 1. The heart of the first full-scale atomic power station in the U. S. The core of the Shippingport reactor being lowered into position. This core contains 14 tons of natural uranium and 165 pounds of highly enriched uranium

Nuclear Power Development



nuclear power reactor technology. This report, issued in May 1953, described in considerable detail the results of studies of four major electric utility company groups on the design of nuclear power plants. In the light of what is known today, the design data in these feasibility studies seems primitive indeed and provides us with a measure of the immense progress that has been made in reactor technology in these past five years. At that time the vast bulk of all the accumulated information and data in the files of the AEC was classified. Today, virtually all information needed by engineers and technicians working in the civilian areas of atomic energy development has been declassified and is easily available. More than 26,000 nonclassified reports have been released. A vast amount of technical material has been published in the 16 large volumes reporting the proceedings of the Geneva Convention on the Peaceful uses of Atomic Energy in 1955. More than 18,000 separate technical reports are available through the Office of Technical Services of the Department of Commerce.

In many other respects we have come a long way in the decade since 1947 when interest in practical nuclear power really began. It has been a period of the most intense and concentrated research ever known. It was marked by the development and growth of great research establishments — Argonne National Laboratory, Brookhaven, Oak Ridge, Los Alamos and Livermore. It brought into being new high-powered accelerators for further investigations in nuclear physics — the Bevatron at the University of California, the giant Cosmotron at Brookhaven with its new principle of strong focusing which makes even larger machines of this kind possible. With these multimillion dollar research tools the frontiers of scientific knowledge have been pushed back far beyond the limits of what was known ten years ago. With their aid new particles have been discovered and some old concepts shattered. The antiproton was discovered, the first man-made mesons were produced by the bevatron at Berkeley, heavy mesons and hyperons, particles previously found only in cosmic radiation, were produced and investigated at Brookhaven, even the elusive, hypothetical neutrino was discovered after many years of painstaking experimental investigation. The detection of this virtually massless, chargeless particle, which can pass through billions of miles of matter, was a scientific achievement of the highest order.

In those ten years scores of new types of reactors were conceived and many of them built. One of the most important of these was EBR-I, the first experimental breeder reactor. Until June 1953, the process of breeding was merely a theory; the idea seemed sound on paper but there was no evidence that a practical breeder reactor would work. Several years before, however, Argonne National Laboratory had started construction of the experimental breeder reactor at the Idaho Testing Site and it had been in operation for many months, when in the summer of 1953, it was announced that the breeding process had been successful. This was an achievement of the utmost significance because it, for the first time, gave promise that *all* of the uranium in the world might ultimately be used in the production of power, not merely the seven tenths of one per cent represented by the uranium-235 content of natural uranium. The experimental breeder was also the world's first reactor to produce electrical energy from nuclear power. On December 20, 1951, steam produced by the heat in the reactor core was delivered to a small turbine generator unit, and a small amount of electric power was produced. On the following day more than 100 kw was generated and the entire building in which the equipment was housed was supplied with electricity from the atomic power plant. This was the first time that electrical power had been produced from nuclear energy.

The decade saw the construction and successful operation of the world's first nuclear power submarines, the Nautilus and the Seawolf, and in this country the pressurized water system of the Nautilus was incorporated in Shippingport station, America's first large nuclear power plant, which is expected to go into operation early in 1958. In the meantime in Britain the Calder Hall station was completed and placed in operation in October 1956, the world's first large nuclear power station to go into service. Before that, however, Soviet engineers had placed a smaller, 5000-kw nuclear power plant in operation as early as April 1954. This, as far as is known, was the first nuclear power station built specifically to generate electricity to go into service.

Great strides were made in international relations in the field of nuclear power in the ten years under consideration. In the summer of 1955, the Geneva Atoms for Peace Conference was held. Here President Eisenhower promised aid to other nations in furnishing enriched fissionable materials. At Geneva also, Russia for the first time disclosed what it had been doing in the field of nuclear power development and research. It was at the opening session of this great conference too that the conference president, H. J. Bhabha of India, surprised the world by bringing up the subject of controlled thermonuclear reactions, and which prodded both the U. S. and the British as well as the USSR into admitting that they all were engaged in thermonuclear research programs. The importance of the Geneva conference can scarcely be estimated. It opened the eyes of many small nations to the realities of nuclear power and it gave the large nations a chance to compare the status of their respective progress.

No review of nuclear energy development during the last ten years would be complete without reference to the great increase in the use of radioisotopes by industry. This is spreading all over the world and is effecting savings wherever they are used. While the nation's first large-scale nuclear power plant still has to be placed in operation, some 250 of the largest U. S. companies and some 1400 smaller firms have been using radioisotopes in all kinds of industrial processes. Although the use of these isotopes is still in its infancy the Atomic Energy Commission estimates that they will save U. S. com-

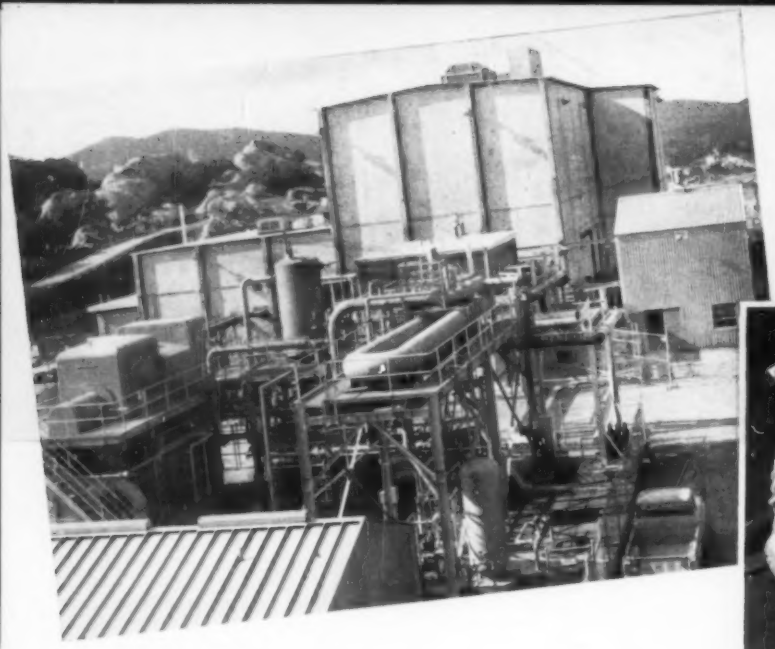


Fig. 2. (Left) This electric generating plant, part of the Sodium Reactor Experiment being conducted by Atomics International, delivers electricity to Southern California Edison

Fig. 3. (Below) Lowering nuclear fuel into the reactor core of the Sodium Reactor Experiment. This plant was dedicated in Nov. 1957

panies more than $500 million this year alone. By 1962 the savings will grow to $5 billion annually, or enough to repay the annual cost of the Government's entire atomic energy program. Today, industrial savings alone return $750 to the national economy for every dollar that the isotope program costs the taxpayer. Yet, only one third of one per cent of the nation's 288,000 manufacturers now use isotopes.

Nuclear Power in the U. S.

One of the reasons we have not made greater progress in the U. S. in the actual construction of large nuclear power stations is that we do not really need nuclear power now. In many countries the critical nature of the fuel situation makes the development of nuclear power imperative if their economies are to survive, but in the U. S. where conventional fuel resources are still ample, there is less need for haste. It is far more difficult for nuclear power plants to compete with conventional plants in the U. S. than it is in other countries where fuel costs are mugh higher. Many technical and financial problems have to be solved before nuclear power can become competitive in this country. Indeed, an analysis of where the industrial atom stands at the beginning of 1958 reveals more clearly than ever before the many difficulties and problems which lie ahead. These problems are sobering in their magnitude but recognition of them should not discourage a new industry which has such favorable long term prospects.

Nuclear power development in the U. S. during the past year was marked by the announcements of several major power projects and the actual start of construction on the first generation of industry-owned nuclear power plants, including those of the Consolidated Edison Co of New York; The Commonwealth Edison Co of Chicago; and the Power Reactor Development Co of Detroit. The year saw the completion of three other nuclear power projects in the AEC's Civilian Power Reactor Demonstration program; first, EBWR, the Experimental Boiling Water Reactor at Argonne National Laboratory which was dedicated in February 1957; second, the start of operation of APPR, the Army Package Power Reactor at Ft. Belvoir, Va, in April; and third, the Sodium Reactor Experiment plant of Atomics International near Los Angeles, Calif. The first privately financed power reactor to be completed was General Electric's 5000-kw Vallecitos plant near San Jose, Calif. This went into full power operation on October 24, 1957, feeding power into the system of the Pacific Gas & Electric Co. This plant was built at a cost of $3 million and was designed specifically as the prototype for the 180 mw Dresden boiling water nuclear plant which General Electric is building near Chicago for the Commonwealth Edison Co.

Another notable event of last year was the start-up of the new Engineering Test Reactor (ETR) at the National Reactor Testing Station in Idaho. This test reactor will more than double the high-flux space available for testing reactor components.

Atomic Power in Other Countries

Because of the critical fuel situation which exists in the western European countries, plans for the development of large-scale nuclear power plants are much more ambitious than they are on this side of the Atlantic. Western Europe is critically short of coal and oil, and therefore needs nuclear power as soon as technical progress permits. On the continent, France, Germany, Italy, Spain, Switzerland, Belgium and Holland, and the Scandinavian countries are all making plans for nuclear power development. Italy is recently reported to have purchased a Calder Hall type of reactor from Great Britain, and a 150 mw Calder Hall type power plant is planned for North Brabant in Holland.

Gros-Welzheim on the River Main will be the site of a 15 megawatt power reactor in Germany. Belgium has a 3 megawatt reactor in operation and work is progressing on a prototype pressurized water reactor of 11 megawatt electric capacity. In France, the 40 megawatt plutonium reactor at Marcoule has been operating steadily and work on other nuclear plants is progressing. The six central European countries comprising the Euratom group plan a total of 15 million kw of nuclear capacity by 1967.

Atomic energy development in Norway and Sweden is interesting because in those countries plans are under consideration for using nuclear energy for the production of steam in industrial processes. Norway has a semi-industrial reactor under construction which, eventually, will deliver steam to a paper pulp factory, indeed, this reactor may be the forerunner of many similar reactors for this industry. Sweden also is developing an industrial reactor called R3A with 76 mw output for district heating. This reactor is being built in collaboration with the city of Stockholm for a suburb, Farsta, and is scheduled to go in service in 1960.

Italy expects to begin producing electric power on a large scale by

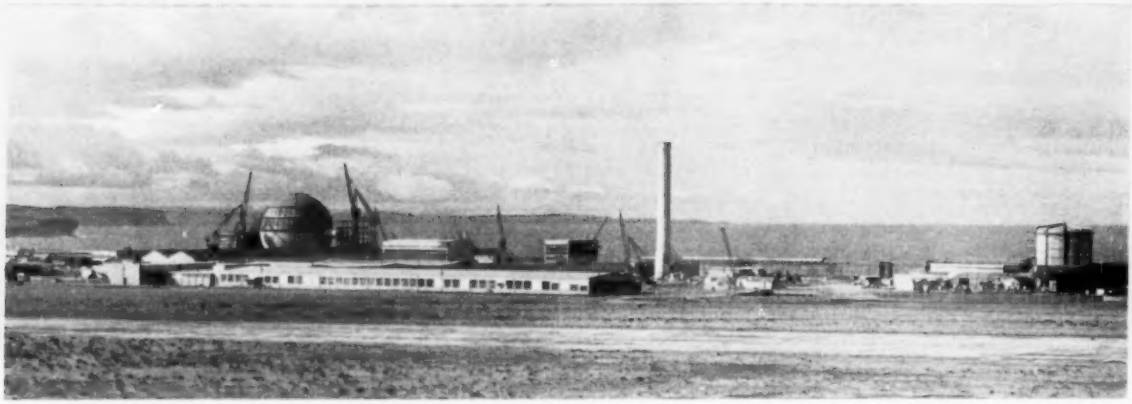


Fig. 4. The Dounreay Establishment on the bleak northern coast of Scotland. This is Britain's first Fast nuclear reactor

1965. The average cost of conventional fuels in Italy is three times that in the U. S., hence nuclear power provides a logical answer to Italy's power problem.

In Spain an Atomic Energy Junta is entrusted with all research and development work in the nuclear field to advise the government. A 3000 kw (heat) swimming pool reactor will be ready for operation in the spring of 1958.

In Great Britain astonishing progress is being made in the nuclear power field. Since the Calder Hall station was placed in operation in October 1956, Britain's already extensive nuclear power program has been trebled. Work has already begun on four of the stations in this extended program, namely, at Bradwell in Essex; at Berkeley in Gloucestershire; at Hunterston, on the Ayrshire coast of Scotland; and at Hinkley Point in Somerset. The contract for the fourth station at Hinkley Point was the last to be announced and whereas the first three are in the 300 megawatt class, the Hinkley Point station will be of the order of 500 megawatts. Hinkley Point, however, is not likely to hold the distinction of being the world's largest nuclear power station very long because two other nuclear stations to be ordered in March 1958 are expected to be even larger — perhaps as big as 800 megawatts. Britain seems well on her way to attain her goal of 6 million kw of nuclear power capacity by 1965.

Britain also is making notable progress in the development of a controlled thermonuclear reaction. Recently an important new piece of equipment for significant research in this field was completed at Harwell. It is a large doughnut shaped device known as ZETA. Preliminary reports indicate this apparatus has achieved temperatures well over a million degrees and neutrons of thermonuclear origin have been produced.

This British work on a controlled fusion reaction is similar to that which is being carried on by the U. S. Atomic Energy Commission. The AEC has begun construction on a multimillion dollar device known as the Model C Stellerator at the Forrestal Research Center at Princeton University. Experimental work with this new device could start late in 1960 or early in 1961. While work in this field being carried on on both sides of the Atlantic has produced a number of extremely interesting developments, it is anticipated that many years will be required to develop a prototype thermonuclear device which will yield more energy than it consumes. However, it is encouraging to know that now the U. S., Great Britain, and Canada are interchanging data and information in this field of research. Russia is also engaged in this field of research but no new disclosures concerning Russia's progress on the controlled fusion reaction have been made since Kurchatov's surprise address at Harwell in England in the spring of 1956. It was evident from that address that Russian work was proceeding along parallel lines with that of U. S. and Britain.

No brief review could possibly even touch upon the countless aspects and ramifications of the last ten years of development in the nuclear field but these few examples will serve to demonstrate the vigor and revolutionary importance of this great new field of human endeavor. Nuclear energy comes none too soon. As explained in the preceding article on World Power Development, the world population outlook is frightening. Every day adds more than 80,000 people to the population of this planet. This growth can only be taken care of if there is an increase in our supply of inanimate energy. And for this requirement there is only one effective ultimate solution — nuclear energy, first through fission and later through fusion.

THE END

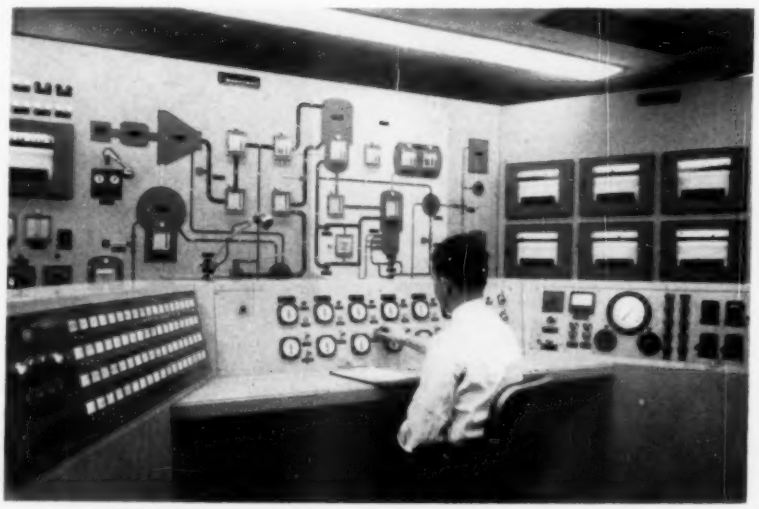


Fig. 5. The control room of the Army Package Power Reactor at Fort Belvoir, Va. This first package nuclear power plant went into operation in April 1957

Science Gives Us More Ideas, New Materials

Utilities:—More supercritical pressure steam-electric units, some planned for 450,000 kw; units with heat rate of 8016 Btu per kwh; more automatic data collection and supervisory control for power equipment and coördination of entire systems; larger gas turbines; heat pumps; coal pipeline. Industrial plants:—New construction materials; new fuel handling methods; coördination in power house planning; high-temperature hot-water systems and their controls

By CHESTER R. EARLE
Editor, POWER ENGINEERING

PROGRESS in power engineering occurs in a continuous stream, not in bits and pieces. Nevertheless it is useful to take a look once a year at the outstanding developments of the year and a look ahead at the possibilities these developments may promise. For several years, we have been chronicling the continuous progress in the field. And that progress has gone on in 1957.

For example in the January 1957 issue, we noted that much work is being done in building units for operation at pressures above the critical (3206 psi) in order to obtain better efficiencies and in turn cut the costs of generating power.

Supercritical Plants: — During 1957, the first of these plants was put into operation at Philo Plant of Ohio Power Co, a member of the American Gas & Electric system. (See POWER ENGINEERING, July.) This is a 125,000-kw single shaft unit, supplied with steam at 4500 psi, 1150 F by a cyclone-fired once-through steam generating unit. It is important for several reasons: 1, it is designed to operate at a heat rate of approximately 8500 Btu per kwh, about 500 Btu less than our best sub-critical plants today; 2, it is the first of a number of supercritical plants now under construction; 3, it has led AG&E to design two more supercritical units of much higher capacity; 4, it is an important step leading to methods by which we can meet the expanding utility loads of the future. As Philip Sporn has pointed out, it demonstrates the dynamic character of the electric power industry and it breaks through the barriers of capital cost and operating cost, thus reducing power costs to the consumer.

The two new supercritical units planned by AG&E are 450,000-kw units and their steam generating units are of a new once-through vertical design, as contrasted with the horizontal design of the Philo steam generating unit (POWER ENGINEERING, July, page 62). As a result of this vertical design, the 450,000-kw unit would occupy a building of 5,560,000 cu ft as compared to a present day plant of two 225,000-kw units, which would require a building of 8,666,000 cu ft. Thus there would be a saving of over 27 per cent in the cost of the power plant building alone.

While the Philo supercritical unit was the first to go into operation, work has been going ahead rapidly on other such units. The Eddystone plant of Philadelphia Electric Co., Fig. 1, is under construction. As noted last year, this plant will contain a 325,000-kw turbine generator, supplied with steam at 5000 psi, 1200 F by a steam generator of the monotube design. These units were described in detail before the 1956 ASME annual meeting by Harlow, Campbell, Franck and Spahr. This unit is designed for the very low heat rate of 8016 Btu per kwh.

For unit No. 2 at Eddystone plant, another monotube steam generator is on order for capacity of 2,178,000 lb per hr, 3725 psi, 1050 F.

Still another supercritical installation, utilizing a monotube boiler, Fig. 4, is that at Avon Station of Cleveland Electric Illuminating Co. This boiler has a capacity of 1,715,000 lb per hr at 3775 psi, 1110 F.

Two other interesting installations of the monotube boiler, but designed for operation below critical pressure, are the 940,000-lb-per-hr, 2565-psi, 1060-F unit for Frank M. Tait Station of Dayton Power & Light Co; and the 1,150,000-lb-per-hr, 2610-psi, 1060-F unit for Portland Generating Station of Metropolitan Edison Co.

Steam Turbines: — For this Portland station, the first of a new type of steam turbine has been designed. This is a turbine with axial flow exhaust. In this unit, the steam exhausts out of the turbine parallel with the shaft and flows directly into a condenser installed at the same level as the turbine. This unit is described in ASME paper No. 57-PWR-6 by Fowler and Matney and details of it are presented elsewhere in this issue.

In these new large units, the problems of the auxiliaries, especially of the boiler feed pumps, must be solved. For example, how much spare boiler feed pump capacity do you need in a modern plant? (See POWER ENGINEERING, May.) What about

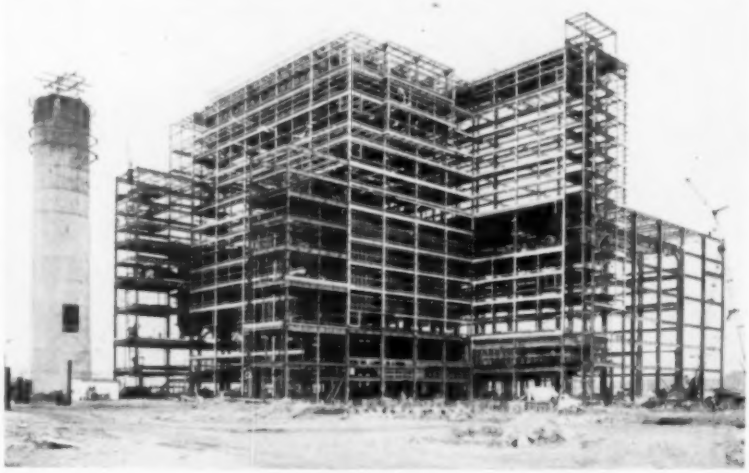
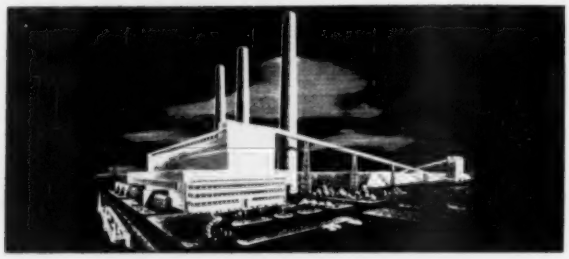


Fig. 1. Steel goes up rapidly at Philadelphia Electric Co's new Eddystone generating station; picture taken November 11, 1957. There a 325,000-kw supercritical generating unit is scheduled for operation in 1959 and a second unit for 1960. Steam for first unit will be supplied at 5000 psi, 1200 F by monotube boiler

for Still Greater Power Field Development



spare b-f pump capacity where the main pump is driven by the main turbine or where a once-through steam generator is used? (POWER ENGINEERING, June). And should the spare b-f pump start be automatic or manual? (POWER ENGINEERING, July)

Fuels: — Although the fuel supply and fuel burning practices of the power industry are not changing rapidly at the moment, engineers are giving considerable thought to the changes that may come in the next 10 or 20 years. The atomic power developments discussed elsewhere in this issue will have some effect on hydrocarbon fuels but the greatest effect will come from the ever-expanding population and industrial expansion. That will require more and more electric power, and greater and greater fuel consumption in addition to atomic energy.

Transport of coal by long pipelines may, in the near future, change the entire coal supply picture in certain parts of the country. The first of such long pipelines (POWER ENGINEERING, September) is now in operation.

But another idea is being seriously discussed these days. Should we burn coal at all, or for that matter, oil or gas? By that we mean, are coal, oil and gas more valuable as raw materials than as fuels? In many industries, especially the steel industry, coal is coming to be regarded as a basic material, from which, in chemical recovery plants, many valuable by products are recovered (POWER ENGINEERING, June, page 74).

What may come out of the development work now being done on fuel cells (POWER ENGINEERING, November), remains to be seen.

Automatic Control: — One of the most important recent developments in the power field is the increasing use of various forms of "electronic brains" — analog and digital computers, and combinations of instruments, data analyzers and telemetering equipment. For example, a Flamingo electronic system, expected to save $40,000 a year, is being installed in Florida to record the condition of the entire power system of Florida and send out at once the information for required adjustments to be made at individual plants. This is merely the latest of a number of such systems. Other systems under automatic control are West Penn, Kansas City Power & Light, American Gas & Electric System.

Automatic data-taking and computation of test results on a boiler at Springdale Station was done by a device called Datak at Springdale, with the data telemetered to a computer in New York City and the results transmitted back to Springdale in an hour. See ASME paper Nos. 57-SA-58 and 57-SA-61.

Quotable quote on the whole subject of computers came from Professor Preston C. Hammer, of the University of Wisconsin, Director of Numerical Analysis Laboratory: "If you have the money to consider a computer, it will pay for itself simply by making you think of the problems to put on it!"

Important consideration for all plants supplying electricity to industry is the effect of voltage variations and short-time power interruptions on industrial processes. This is especially important in mass-production industries where computers are used for controlling production, for these computers are extremely sensitive to voltage variations (POWER ENGINEERING, July).

Materials: — It is axiomatic that it is the development of new materials or improvement of existing materials that makes progress possible in the power field. For example, the 5000-psi 1200-F power plant noted above could not have been designed if Type 36 stainless steel for high-temperature piping had not been available, as well as the superalloys for construction of the finishing superheater and the supercritical turbine rotor.

For less extreme conditions in many industrial power plants, polyvinyl chloride (POWER ENGINEERING, October), forms a versatile new material for pipe and fittings, tanks, ducts, cooling towers and the like, to cut maintenance.

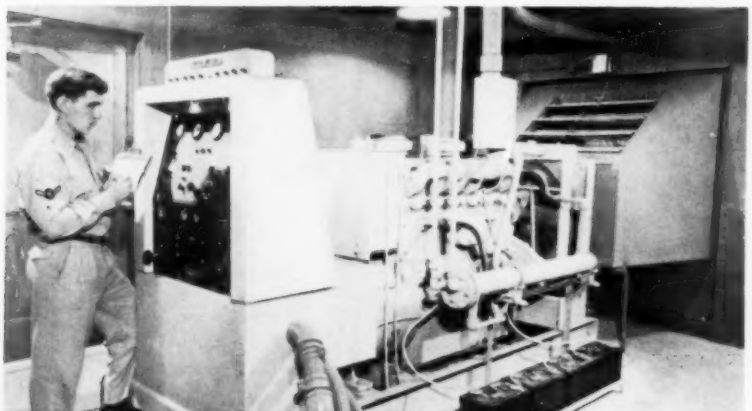


Fig. 2. This is a complete 60-kw diesel power plant that thinks for itself (PoE, April). It is completely automatic; no attendance required except to read instruments. Plant starts and stops automatically, cuts in a duplicate unit in emergency. Suitable for hospitals, institutions, essential emergency or standby power anywhere

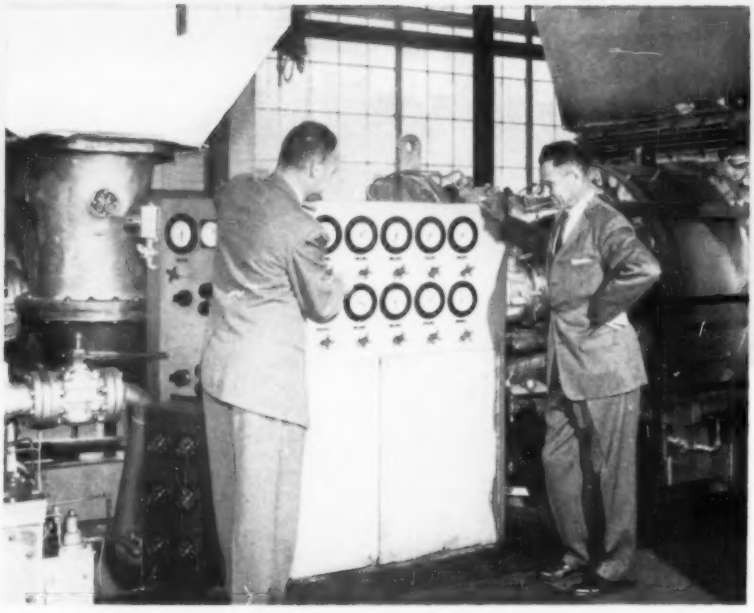


Fig. 3. At Gates Rubber Co, Carl Metcalf, left, and Clarence Payne at control panel of 5000-kw gas-turbine generator that supplies exhaust heat to a steam boiler generating process steam

Although use of high-strength bolting for steelwork in buildings is not new, it has recently received considerable attention and has been used in erection of power plant buildings (POWER ENGINEERING, May).

Water Treatment: Necessity for providing water of the highest purity for atomic reactors and supercritical pressure power plants has led to the use of demineralizers yielding water of only 0.001 ppm of dissolved solids and very low silica, and with close control of alkalinity. Nevertheless, in many industrial and utility stations, the well-known processes of evaporation, ion exchange, zeolite systems and internal water treatments still produce water of required purity (POWER ENGINEERING, February). Proper attention to blowdown, and especially the use of continuous blowdown, help in controlling boiler concentrations. In the December issue, we reviewed several ways of converting salt and brackish water to fresh, including the new ion exchange membrane method and the spinning disk evaporator.

Waste Treatment: — Outstanding in this field is the announcement by a municipal sewage treatment system that it is installing a pilot plant to test the possibility of using the Zimmerman process to treat sewage. In this system, the chemical reactions "burn up" the waste material without combustion in furnaces. If it works out, this process could produce many changes in our present methods of sewage and waste disposal.

High-temperature Water Systems: — Interest in using these systems for industrial and commercial building heating is increasing. One of the first installations in industry was described in POWER ENGINEERING, March. In some ways, control of these systems requires methods somewhat different from those needed with steam heating systems, as discussed in POWER ENGINEERING, September.

Space Heating, Heat Pumps, Air Conditioning: — These are important subjects for most power engineers today. Electric space heating, up to the present, is principally confined to houses, and is a load builder for the power utilities. However, the heat pump is also a potent potential utility load builder. But as for economy, it is the big job-engineered heat pumps for industrial and large commercial buildings (POWER ENGINEERING, August) that are of most interest to power engineers.

These make the big savings. Two-stage compression is recommended. The units are of the order of 500 tons capacity. A 12-story building in Portland, Oregon, of 2,275,000 cu ft. has

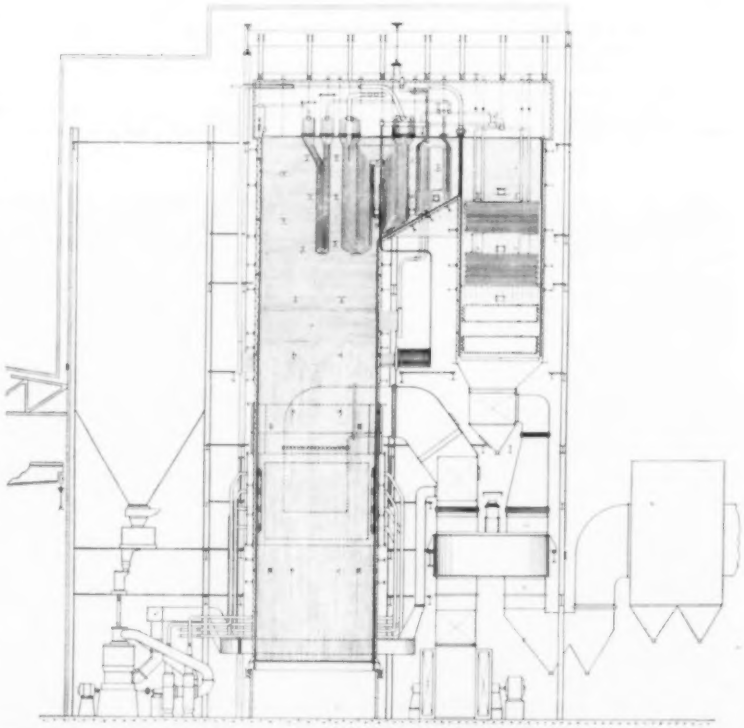


Fig. 4. Cross-section of one of the monotube steam generating units for supercritical steam conditions of 3775 psi 1100 F, installed at Avon Station, Cleveland

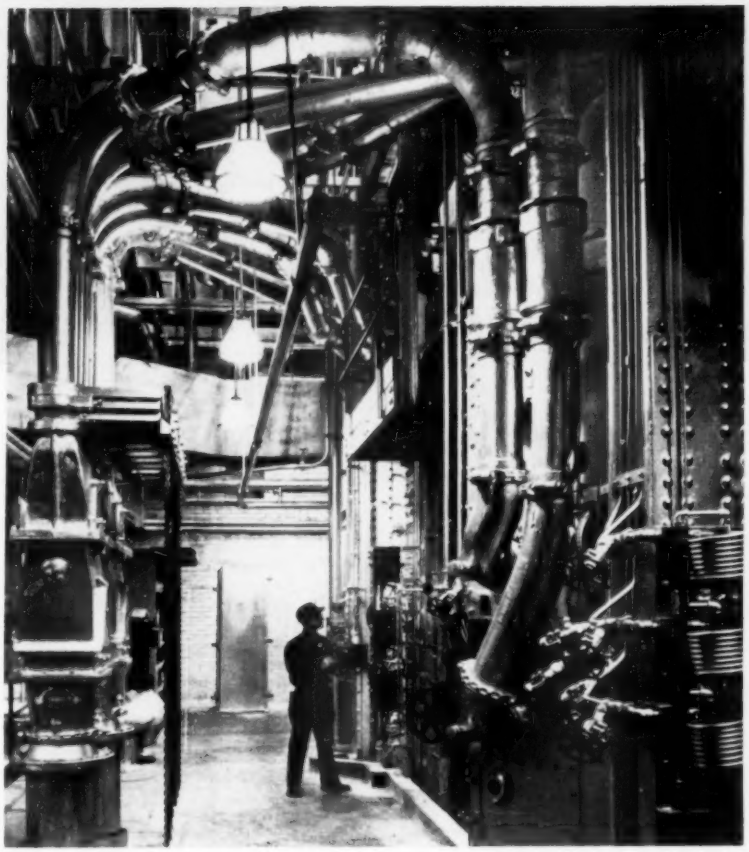


Fig. 5. This dramatic shot shows the new 240,000-lb-per-hr 1290-psi, 800-F, pulverized-coal-fired boiler at Mando's plant, supplying steam to a 6200-kw topping turbine put in at same time

a heat pump system with an operating cost for heating of 2.1 cents per sq ft and for cooling 7.74 cents per sq ft. Smaller capacity heat pumps, eliminating ductwork, can be assembled from package units (POWER ENGINEERING, September).

Gas Turbines: — As reviewed in the October issue, gas turbines are marching on. It is now possible to build them in the open-cycle type for capacities up to 21,500 kw, like the unit for Caracas, Venezuela. Thus they are beginning to get into the size range of small private and many municipal utilities.

More important, however, is that power engineers are looking more frequently at combination gas and steam turbine plants, like Gates Rubber Co or the one planned for Cordele, Georgia. In several cases, gas turbines have been superimposed on existing steam plants, the gas turbine exhaust heat being used to heat feedwater in the steam cycle. But the possibilities of using the gas turbine exhaust gases, rich in oxygen and high in temperature, to generate steam in a boiler, supplemented by boiler fuel, the steam driving a turbine, seem attractive. Increases of 5 or 6 per cent in efficiency, as compared with the standard steam plant, have been estimated. Also, the free-piston engine and gas turbine combination looks attractive. Engineers will hear more from this new prime mover.

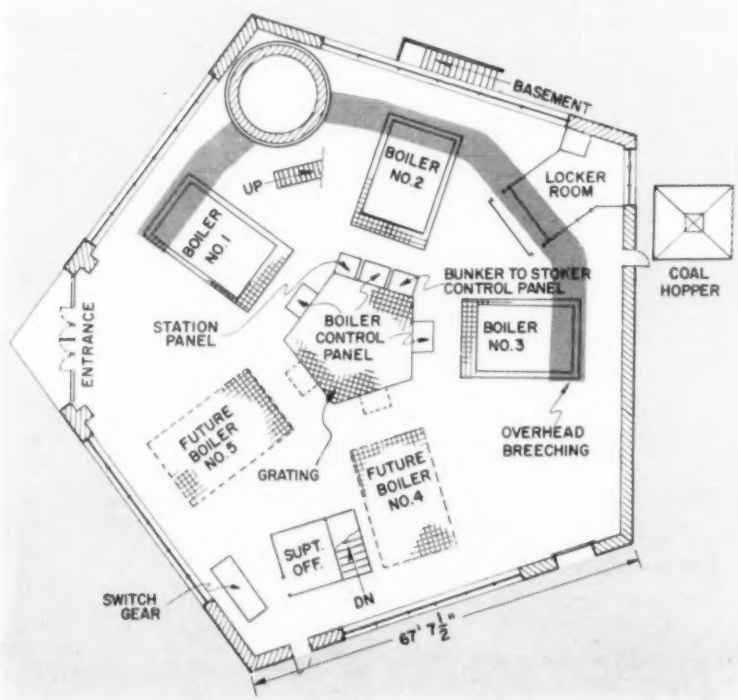


Fig. 6. Coördination meetings of designers and contractors (PoE, October) obtained best value for their money and built this unusual pentagonal power plant

Hydroelectric: — Principal development of the year was the final decision to allow the Power Authority of the State of New York to build the long-planned Niagara Power Project. Technical data on this will be given in a later issue.

Work continues on PG&E's underground Haas power plant on the King's River development.

A large Midwestern utility company is considering construction of a pumped storage hydro plant and a New Jersey utility is also studying the feasibility of such a plant on one of the Eastern rivers. THE END

Progress in Solid State Phenomena Advances Electrical Art

Host of solid state developments of the past decade have already changed the basic character and behavior of many present-day circuits but even more revolutionary developments are expected in the future. Superconductivity, magnetic effects in semiconductors, nonlinear capacitance in junctions, molecular amplification—these and many others present new possibilities in the field of circuit design

THE MEASURE of progress or rate of development of an industry is usually expressed in terms of its financial growth or by the increase in size or number of units or by its sheer overall magnitude. The electrical industry is no exception to this method of appraisal and those of us who work in it are quite familiar with the rate at which the industry as a whole has been growing each year. With respect to total generating capacity for example, we know that this has been doubling approximately every ten years, and there is little reason to believe that this rate will change materially during the next two decades. This year, for example, in the United States we have a total of 130 million kilowatts installed in the central stations of this country. From the pattern that has been set and taking into consideration such factors as population growth and the steady increase in gross national product, we can predict with considerable assurance that in 1970 — just 12 years from now — we will have a generating capacity of around 360 million kw.

This enormous increase in the demand for electric power imposes a great many difficult problems which will have to be met in the years to come, problems which involve size and capacity of individual generating units, multiplication of transmission and distribution facilities, questions of higher and higher voltages with consequent insulation problems, limitations of existing types of switching equipment, and, of course, control problems of ever-increasing complexity and magnitude. Complex economic questions arise, social and political problems involving rights of way for transmission facilities have to be met, indeed, the ramifications are all but endless.

While statistics concerning present and future capacity, size and number of units, and related plant data reflect the growth and vigor of the industry, there is another measure of progress of perhaps even greater significance, and that concerns the amount and kind of basic research that is going on. Those most familiar with the industry today know that practically everything in the electrical industry is based on fundamental investigations made in research laboratories in years past, and today, more than ever before, the future of the industry depends upon what is going on in the research laboratories of the world.

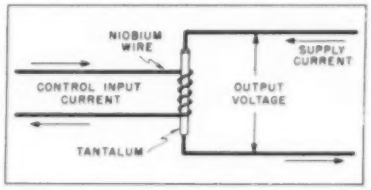


Fig. 2. The Cryotron, which gives us a useful flip-flop device for computers

Electric circuits were once largely confined to the use of conductors, insulators, magnetic metals, in combination to produce inductors, capacitors, and resistors, and dependent on electron tubes for amplification and non-linear effects. Circuit designers still use these elements, and will for many years, but in the meantime as a consequence of advanced knowledge in the realm of solid state physics, a variety of new concepts have been slowly emerging. During the last ten years an almost countless number of solid-state materials and effects have been used to obtain gyrators, static switches, memory elements, amplifiers, rectifiers, electro-optic transducers, and thermoelectric devices. As pointed out recently in the IRE Proceedings by Dr. Edward Herold of the RCA Laboratories, we may look forward to the day when the chemical synthesis of an improved compound, the technology of its use, or the discovery of a new, useful effect in these solids can do more to revolutionize the performance of an electric circuit than all the classic ingenuity of the circuit designer.

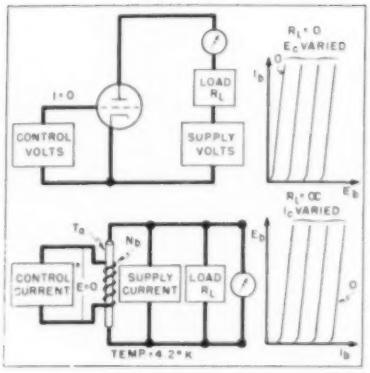


Fig. 3. Diagrams showing how the cryotron can be connected to behave as the counterpart of the triode electron tube

Despite the obvious simplicity of an electric switch — merely a device to make, or break, an electric circuit — circuit interrupting devices, which is another way of referring to switches, have given electrical engineers no end of trouble, and countless years of effort have gone into the design of modern switching equipment to overcome its basic shortcomings. The dream of any circuit designer is the achievement of a static device of some sort that would change from a

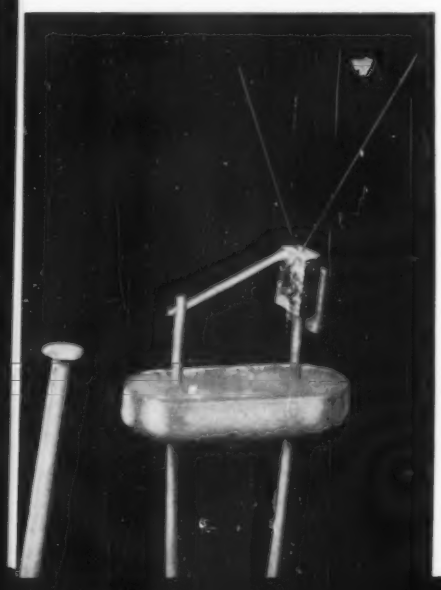


Fig. 1. Experimental assembly of the Spacistor developed by Raytheon. This new device promises to combine many of the best properties of the thermionic vacuum tube and the transistor

good conductor to a good insulator at the will of the operator or control device. The transistor is such a device and for weak currents it gives the circuit designer what he has dreamed about, and in England recently an experimental telephone exchange having no moving parts whatev was placed on exhibition at Pye Telecommunications Ltd. Our own Bell Telephone System, as a result of its pioneer research in the field of semiconductors, has as its ultimate object a nationwide telephone system involving completely static switching. In this system transistor type switching devices combined perhaps with non-linear magnetic equipment would replace the millions of electromechanical relays which now perform the switching operations.

Our knowledge of solid state phenomena is comparatively recent. All our early knowledge of the mechanism of electric conduction came from studies of electric conduction in liquids and gases. This probably was inevitable. Man's first concern with practical electrical devices demanded an explanation of the electric battery and batteries used electrolytes. Thus, from the beginning there was a fairly good understanding of how electricity is conducted through liquids. Later, when the arc lamp came into use, and still later when electrical discharges through gases became the object of serious study, the mechanism of gaseous conduction was gradually uncovered. In these early years very little sustained attention was given to the way in which electricity is conducted in solids or why it is not conducted in insulators. Only in recent years, since the brilliant investigations by Shockley, Bardeen and Brittain at Bell Telephone Laboratories were begun in the early 1930's, have we come to understand more clearly just what goes on in a solid when it is conducting electricity. The great advance in this area of understanding came with the concept of *hole* conduction.

Although the hole and its negative counterpart, the excess electron, have been prominent in the theory of solids since the work of A. H. Wilson in 1931, the announcement of the transistor in 1948 has given holes and electrons new technological significance. From the theoretical viewpoint, the hole is an abstraction involving detailed quantum-mechanical considerations. In contrast, from the experimental point of view, the existence of holes and electrons as positive and negative carriers of current can be inferred directly by the experimental techniques of transistor electronics so that holes and electrons have attained an operational reality of utmost practical significance.

This is reflected not only in the innumerable new solid state devices which have made their appearance during the last ten years but also in our better understanding of the Hall Effect which was discovered first in 1879, and of basic molecular phenomena at low temperatures.

The cryotron is an example of a practical device which resulted from our better knowledge of the behavior of solids at extremely low temperatures. This clever little device which has been exciting computer engineers lately makes use of the fact that a magnetic field affects the superconducting transition temperature. As is well known, at temperatures around a few degrees Kelvin certain conducting materials suddenly lose all their electrical resistance — the resistance becomes zero. However, the exact temperature at which this transition occurs can be shifted by applying a magnetic field, and this principle is made use of in the cryotron. By the sudden application or removal of the magnetic field, the cryotron can be made superconducting or not, and this gives us a flipflop device useful in computers. A cryotron is made, as shown in Fig. 2, with a coil of fine niobium wire wound around a small tantalum wire. The whole device is about the size of a small pin and thousands of them can be concentrated in a small vessel filled with liquid helium.

Strangely enough, the cryotron can also be used as an amplifier, and as shown in Fig. 3 it is almost the exact dual of a grid controlled triode electron tube. The only difference is that in the characteristic curves every current is replaced by a voltage, and every voltage is replaced by a current.

Now let us consider some practical applications of the Hall Effect. Until recently this was largely a laboratory phenomenon; now with the increased knowledge of semiconductor materials, practical and valuable applications loom on the horizon. The Hall Effect occurs when a current-carrying conductor is placed in a transverse magnetic field. The force on the current, given by Ampere's Law, is such that the current paths are pushed in a direction at right angles to themselves and to the magnetic field. If the charge carriers are positive, a transverse emf is set up of one polarity. Negative charges give an opposite emf.

Figure 4A shows the principle of the Hall Effect, and Figs. 4B and

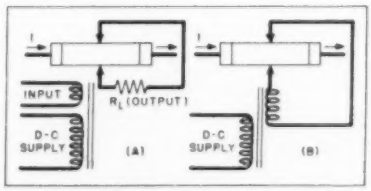


Fig. 5. Hall Effect amplification. A, Amplifier. B, Regenerative feedback

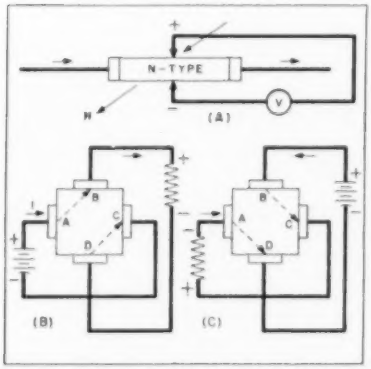


Fig. 4. A, The Hall Effect. B, Diagram of the gyrator connected in the forward direction. C, Diagram of the gyrator connected in the back direction

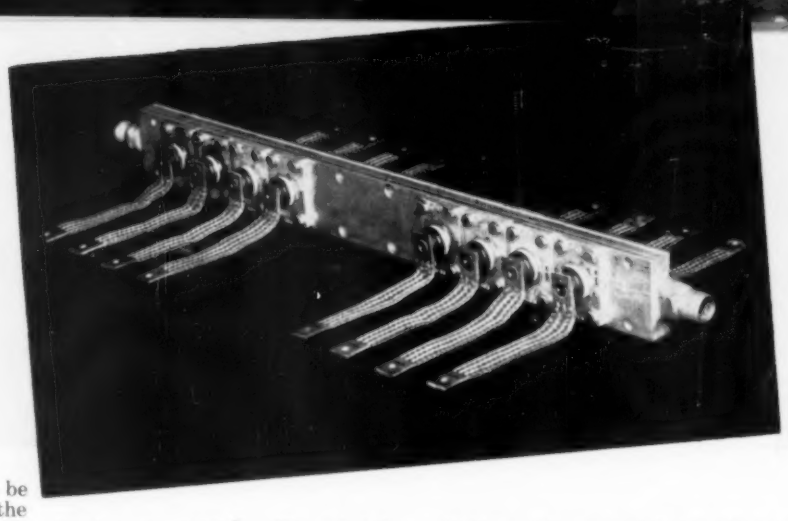


Fig. 6. Silver-plated, hollow, water cooled, bus bar mounting holds 8 germanium rectifiers, rated at 65 v rms and 83 amp each, is an application of our new knowledge of solid state phenomena

4C shows how the Hall Effect can be used to form a gyrator. Because the ferrite gyrator works only at microwave frequencies, those familiar with the device are prone to ignore it as a circuit, applicable to, say, a doorbell wiring system, yet the Hall Effect provides an extremely simple nonreciprocal, passive, four-pole circuit element which works from d-c up to very high frequencies. By building a symmetric square, with four side contacts as shown in Fig. 4 (A), it is seen that in a magnetic field electrode

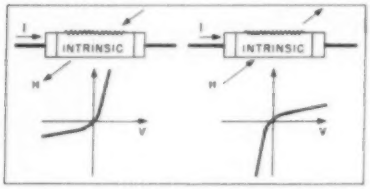


Fig. 7. Diagrams and characteristics of the magnetic rectifier—a bulk effect

A can be thought of as having a resistive connection to B, and C to D. A battery poled as shown, that is with the positive terminal to A, produces a positive output on terminal B to the load resistor. The source current into a terminal is deflected clockwise and the upper end of the load is positive. Reversing the battery and load resistor as in Fig. 4 (B), the source will flow into B and again will be deflected clockwise. The positive terminal now, however, is the bottom end of the load. Thus it is seen that the output of the four-pole used in one direction is 180 deg out-of-phase with the output used in the other direction.

Figure 5 shows how the Hall Effect can be used as an amplifier. It is found that an input magnetic field can be applied, with a load resistance in the transverse connection, to give a power gain. In a feedback arrangement, also shown, negative resistance effects have been obtained.

An even more intriguing outgrowth of the Hall Effect is the novel semiconductor rectifier shown in Fig. 7. This differs from all other rectifiers in that it uses a bulk effect rather than a barrier or contact. The sketches above the characteristic curves show a slab of approximately intrinsic semiconductor, with a transverse magnetic field. One surface is sand-blasted, and the other has a very low re-combination surface, and (in equilibrium) is also a high carrier generating surface. When a voltage is applied with the left-hand terminal positive, the holes and electrons generated at the upper surface and in the bulk are driven downward toward the low re-combination surface. As a result of very little re-combination there, a high carrier concentration results and a high current can flow. Upon reversing the voltage, the carriers are driven to the sand-blasted surface, which has an extremely high re-combination rate. Thus the concentration of carriers becomes low and little current flows. By reversing the magnetic field, the rectifier is reversed in polarity. Here then, we have a rectifier in which the polarity can be reversed at will — an extremely interesting and unusual device from the circuit point of view and one that will undoubtedly find use in special applications.

Another novel idea, shown in Fig. 8, is that of a semiconductor variable capacitor. Many circuit investigators have explored, in a modest way, the utility of the depletion layer capacitance of a point-contact or junction rectifier. It is well known that when such a diode is biased in the reverse direction, an insulating, charge-free layer builds up whose thickness depends upon the reverse d-c voltage. This layer is a relatively low-loss dielectric, since any charges generated there are quickly swept out and produce no a-c effect up to quite high frequencies. Thus, the junction can be regarded as a capacitor whose value depends on the d-c voltage applied to it. This idea is shown in Fig. 8. While commercial diodes are not made for this purpose and have high losses, it is not difficult to design units with low series resistance, and this has been done with good results. It has been applied as am-fm modulator and has also been used in color television equipment. As a nonlinear capacitor, various switching devices, dividers, mixers, and harmonic generators can be devised.

These few examples are typical of some of the ideas and devices which are emerging from the continuing research in solid state physics. In a brief review we have barely scratched the surface of this fascinating field. Nothing has been said about the Spacistor, or the drift transistor, both of which give promise of extending the usefulness of transistors into the very high frequency range. Nor is space available to describe the work

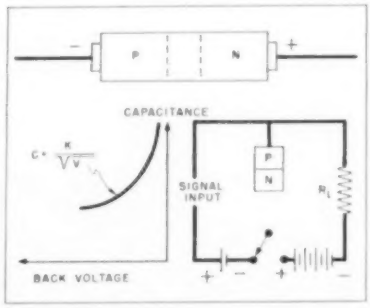


Fig. 8. The p-n junction semiconductor used as a variable capacitor

being done with masers or molecular amplifiers, a class of microwave amplifiers and generators which do not require electric charges or currents, as in the electron tube or transistor. Indeed, as this is being written, Harvard University announces the development of a new maser, a 3-level solid state maser which may enable man to *hear* the radiation from hydrogen clouds in galaxies beyond the range of present instruments. Also, General Electric has just announced a breakthrough in the direct conversion of heat energy into electrical energy by means of a new thermionic converter. Details of this development are presented on page 87 of this issue. While still purely in the experimental stage it is not outside the range of possibility that the principle involved in these laboratory devices may someday be used to replace our huge rotating turbine generating units. THE END

Kingsley Rice (center) with Andrew Kramer (left) and Chester Earle in POWER ENGINEERING's new offices in Barrington, Ill.

POWER ENGINEERING Editors Promoted

Kramer becomes Assistant to President and Editor of ATOMICS . . . Earle to be Editor of POWER ENGINEERING

KINGSLEY L. RICE, president of Technical Publishing Company, publisher of POWER ENGINEERING and *Plant Engineering*, announces a shift in top level editorial responsibility for POWER ENGINEERING.

Andrew W. Kramer, editor of the magazine since 1948, has been made Technical Assistant to the President and Editor of ATOMICS.

Chester R. Earle, who has been serving POWER ENGINEERING in managerial editorial posts since 1948, now takes over as Editor.

Richard H. Morris continues as Editorial Director of POWER ENGINEERING.

Kramer and Earle, as well as Morris, are widely known for their journalistic activities in the power engineering field, and together form a trio of engineering talent which has long been identified with Technical Publishing Company. Kramer began working as an associate editor on *Power Plant Engineering* (later renamed POWER ENGINEERING) in 1920. Earle joined the staff in 1924, while Morris has been in the company since 1926.

Commented President Rice: "Andy and Chester have been more than business associates to me. They have been warm personal friends for many years. I value their loyalty to our company and their dedication to editorial ideals far more than words can express. Their kind of loyalty and dedication goes deeply into the roots of our organization. It rubs off on the younger people coming along and is sensed by the readers of POWER ENGINEERING."

Rice explained that the changes in titles and responsibilities have not been made simply as a reward, but for sound publishing reasons. They give broader scope to the unusual talents, experience and judgment of these well-known editors.

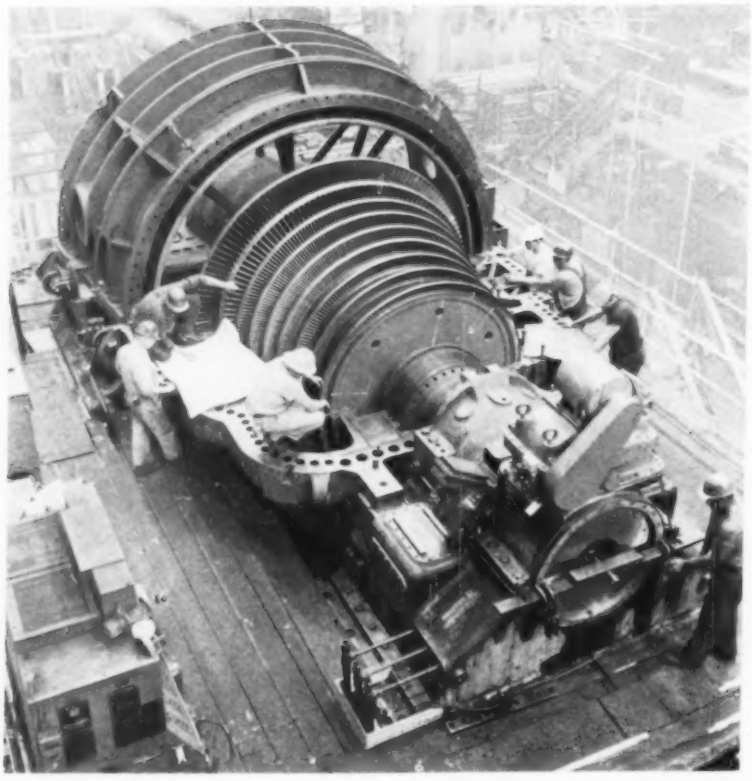
"We are in a better position," Rice said, "to foresee and appraise new developments in the changing and dynamic field of power engineering, and to relate these changes in a practical way to the daily work of power engineers everywhere."

Since 1945, when ATOMICS made its first appearance as a special section in POWER ENGINEERING, Andy Kramer has been deeply immersed in the nuclear energy field. He has had a splendid background for this. Educated as an electrical engineer at Armour Institute (now IIT), he was a radio amateur as early as 1912, and has grown up with electronics. His books, Electricity — What It Is and How It Acts, and Industrial Electronics, are well known to power engineers.

When the Atomic Bomb Test Expedition to Bikini was organized in 1946 it was natural that Kramer should have been chosen as one of only two technical magazine editors to be a member of it. Shortly thereafter he was chosen as a member of the Advisory Committee on Technical Information of the AEC.

In developing ATOMICS his aim is to present information on nuclear matters that is different from the data commonly available and to interpret it in terms that have practical meaning to the power engineer.

Chester Earle continues to bring to POWER ENGINEERING a wide acquaintance and solid background in the field. He was graduated with a B.S. in Mechanical Engineering from Tufts University, and has had power engineering operating experience, as well as experience in the design and application of automatic controls and instruments to all types of power plant equipment. He is a Registered Professional Engineer and a member of many engineering organizations.



History of power-station design is a record of continuous improvement in over-all efficiency and an ever-increasing use of automation. Important new steps are being taken at Portland Station of Metropolitan Edison Company

Fig. 1. Shop photo of low-pressure unit under construction illustrates clearly axial-flow-exhaust turbine arrangement. Pressure after last stage is actually lower than condenser pressure. Turbine shown is for a Carolina plant

Monotube Boiler, Axial-Flow-Exhaust Turbine Make Unique Combination

PORTLAND IS a new station located on the Delaware River approximately five miles below the Delaware Water Gap, near Portland, Penna. Circulating water is available to support over 1,000,000 kw, and the plant is designed for an ultimate of at least six units. Capacity of the first unit will be about 165,000 kw, allowing for a ten per cent overload above the manufacturer's maximum rated capacity of 150,000 kw.

Specifically, Portland is unique in the combination of three features: 1, a subcritical-pressure monotube steam generator; 2, a close-coupled cross-compound axial-flow-exhaust turbine and side-entry condenser; and 3, direct energy-balance combustion control.

Other distinguishing but less significant features include welded condenser tubes, all-welded high-pressure heaters, small bunkers with automatic coal-handling and active outdoor storage, a floating high-pressure deaerating heater, high-speed boiler feed pumps, and two-pressure operation.

Station is basically a semi-outdoor design with the turbine, generator and auxiliaries, and front and lower parts of the steam generator indoors. Figure 2 shows a section through the station with the relative elevation of the various pieces of equipment.

Steam Conditions and Cycle

Choice of steam conditions was based on the desire to utilize as high an initial pressure as could be justified for the size of the unit, but to limit the temperature to 1050 F to avoid the necessity of using austenitic-steel piping. Final choice was 2400 psi nominal pressure, 1050 F initial temperature, and 1050 F reheat temperature.

Nominal operating steam pressure will be maintained until turbine-inlet valves are wide open, at which time the controls will be reset to increase to and maintain an operating pressure of 2520 psi in order to get additional capacity from the unit.

Seven stages of feed heating are provided in the cycle, with a drain cooler above the highest-pressure heater for cooling drains from the water separator before they are returned to the feedwater circuit. The use of this drain cooler reduces the flashing head of water entering top heater and results in both a lower cost heater and a slightly-improved cycle efficiency.

Deaeration is provided in both the condenser hotwell and the deaerating heater. The latter is unusual in that at full load the heater operating pressure is higher than customary for deaerator service — 165 psi. The savings effected by the elimination of one closed high-pressure heater more than offset the additional cost of the higher pressure deaerator. This arrangement also has other advantages, such as less probability of high-pressure heater maintenance, and a wide range of unit loading with positive deaerator operating pressure.

Amount of the improvement effected in cycle efficiency by the use of an axial-flow-exhaust turbine and side-entry condenser has yet to be determined in service. The Portland unit is the first large turbine built by the manufacturer which is designed to improve overall heat rate by (a) reduction of the leaving loss with omission of customary 90-deg bend and (b) reconversion of velocity energy in the steam leaving the last-stage wheel to potential energy in the condenser. In other words, the absolute pressure at the exit of the last-

stage wheel is expected to be lower than the absolute pressure in the condenser.

Monotube Steam Generator

The steam-generating unit is conservatively designed to deliver 1,150,000 lb of steam per hr at 2610 psi, 1060 F superheat, and 1060 F reheat with a furnace heat release of 89,000 Btu per sq ft of effective projected radiant surface.

This monotube steam generator has several characteristics which distinguish it from conventional steam generating units. There are no large heavy walled drums or downcomers; however, there are three pressure vessels — two water separators and a by-pass separator. The location of these vessels is not restricted to any particular elevation; however, in the case of the Portland unit there was a space advantage in locating them near the top of the furnace as shown in Fig. 2.

Absence of heavy-walled pressure parts eliminates the problem of thermal stresses which restrict the operating flexibility of large conventional steam-generating units.

The water and steam side of the monotube unit is divided into two halves each having separate controls. In the steam-generating section of the unit each half is divided into six circuits. The flow to each of these circuits is controlled by a special sleeve-type throttling valve. Each half has its own water separator located between the evaporating section and the primary superheater. Solids are concentrated in the water separator and approximately four per cent of the total flow is bled back into the cycle through the water-to-water heat exchanger shown in the heat-balance diagram, Fig. 4.

Water flow to the unit is controlled by two pressure-difference regulating valves and two flow regulating valves. The flow regulating valves take their impulse from one thermostat located on the outlet of the steam-generating tubes and from a steam-flow orifice located after the water separator.

Any one tube in each circuit can be designated as a control tube since all tubes have a throttling valve at the inlet and a thermostat at the outlet. Only one tube in each circuit is used at a time for control and the throttling valves are adjusted so as to give this tube steam with 50 F superheat while the remainder of the generating tubes in the circuit produce steam with four per cent moisture.

Steam-temperature control is similar to that for conventional C-E units with a combination of tilting burners and spray desuperheaters. Advantage is taken of radiant superheaters to give a flat temperature control over a wide range of steam flow.

Another advantage of the monotube boiler is that it can be brought up to full pressure and the desired steam temperature rapidly. Experience with similar units in Europe has demonstrated that this can be accomplished in one hour or less. This feature is desirable in matching steam temperature to turbine-metal temperature for starting after a short shutdown, but has the disadvantage of requiring special controls, special valves, and unusual piping hook-ups that are not found in a conventional cycle.

However, a bypass arrangement with a conventional unit to make possible matching temperatures on startup is just as complicated and requires as many valves. The monotube system provides for passing a minimum of approximately 30 per cent full flow through the evaporating section of the unit during startup, and approximately 10 per cent to 30 per cent of full flow through the superheater and reheater is required to establish the desired steam temperatures.

Axial-Flow-Exhaust Turbine

Unit No. 1 at Portland is the first large close-coupled cross-compound axial-flow-exhaust turbine purchased from General Electric Co. The low-pressure turbine is a single-cylinder unit and it has the same center line as the condenser. The turbine manufacturer has conducted a series of tests in conjunction with the con-

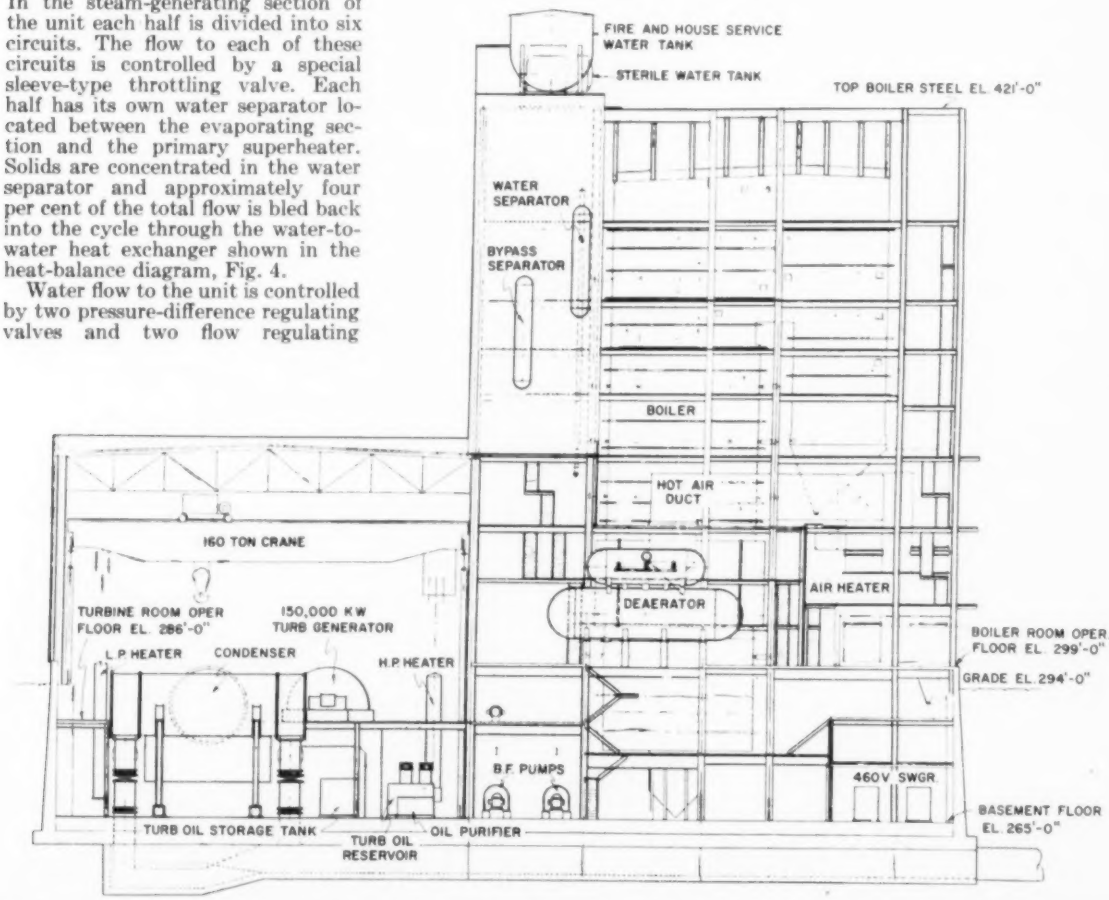


Fig. 2. Section through plant shows economy in building and foundations made possible by placing condenser at turbine level

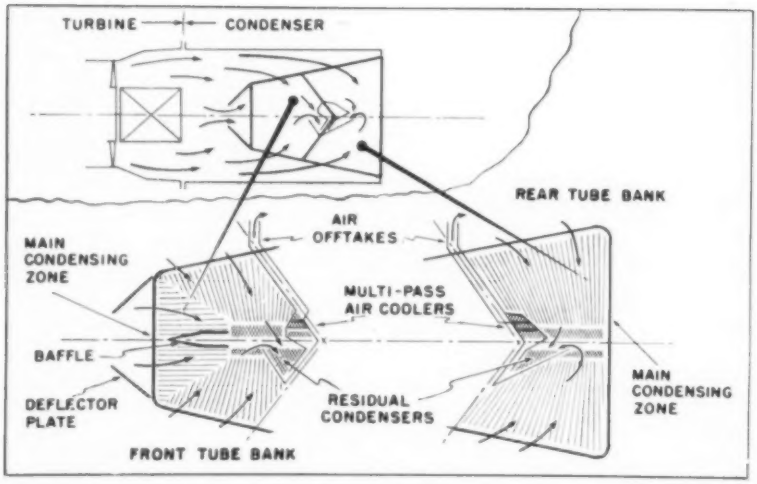


Fig. 3. Sketch showing condenser flow, designed to capitalize on velocity of the steam leaving last stage, diffusing it without building back pressure at bucket

denser manufacturer to determine the shape of the turbine-condenser connecting piece for maximum recovery of velocity energy. Tests will be conducted to determine the extent of this improvement.

Side-Entry Condenser

One interesting effect that should be noted is the arrangement in elevation of the axial-flow turbine in the station relative to the other equipment. Fig. 2 shows that the turbine operating floor is 13 ft lower than the boiler operating floor and 8 ft lower than the grade elevation outside the building. The condenser height above normal water level was the controlling elevation and all other elevations determined therefrom. The turbine-foundation height is approximately 21 ft which is a substantial reduction from that normally required for the conventional arrangement.

The choice of condenser design for use with the axial-flow exhaust turbine is most important if the expected improvement in cycle efficiency is to be achieved. To accomplish this, Ingersoll-Rand, the designer and builder, has collaborated closely with G-E (as stated above) to establish the optimum shape of the turbine-condenser connecting piece. Of necessity the condenser is of side entry type. It is single pass with divided water box and has 80,000 sq ft of surface. The details of the design are shown in Fig. 3.

Condenser leakage cannot be tolerated because of the feedwater purity required by the monotube steam generator. To minimize the possibility of leakage, the manufacturer is welding the tubes in the tube sheet utilizing a new process developed by Revere Copper and Brass. Tubes are admiralty metal and tube sheets silicon bronze — two materials that tests show to be readily weldable.

Hotwell has capacity equal to 10 min of full-load requirements or 14,000 gal. and is designed for maximum possible deaeration. Arrangements also are included for injection of steam from the bypass directly into the condenser during startup of the monotube unit.

Combustion Control

Two basic methods are provided by the L & N combustion control, the direct

continued on page 99

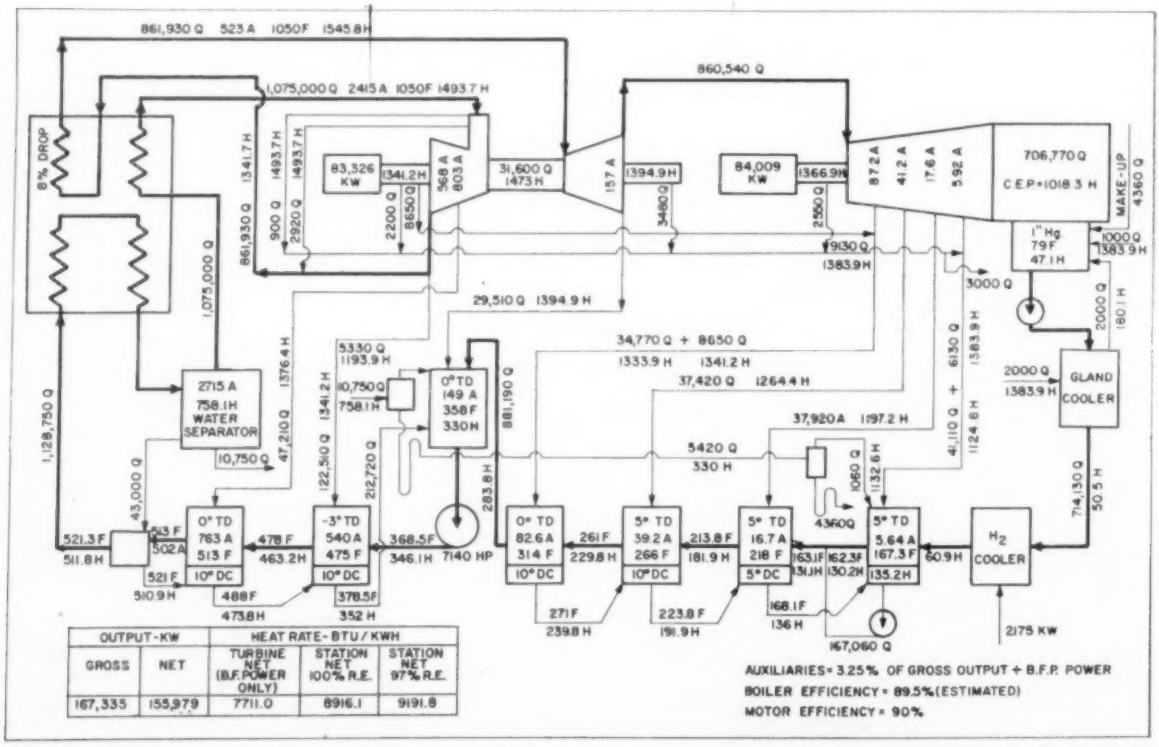


Fig. 4. Cycle heat balance diagram reveals system is conventional except for heat exchange after last heater (lower left)

Editor's Note:

This is the fourth in the author's continuing discussion of how to plan for and organize a new power plant.

A fifth, and final, article is scheduled. Want reprints of all? Write the Editor.

Here's a practical rundown of the many considerations that will occupy the power engineer's attention as he prepares to put his newly-built power plant into the operating state

So You're Ready to Begin Operating That New Industrial Power Plant

By PAUL N. GARAY

IN GENERAL, in preparing your new plant for actual operation, you will need to blow out, wash out, clean out all equipment; leak test all equipment, including boiler air casings; run in your machinery; check, and if necessary, realign all your couplings; set and adjust all pressure and temperature regulators, and other controllers; bake out boiler refractory; test all safety devices; test all gages, indicators and meters. Figure 1 shows a simply made test instrument that will come in handy for this process.

You will have to learn to operate this *specific* plant. Even though your crew may be experienced, each plant is different, and close watch must be kept on all the possible variables, and the results, to enable operation at the best possible conditions.

When starting up a cold boiler, don't force it. For a large boiler, a 100 F temperature rise per hour is enough. When shutting down, don't let cold air blow through the furnace to cool it down. Shut all the dampers.

In the initial warm-up of long steam lines, be very careful, as the process is a slow one, since you will also have to warm up, for instance, the earth around buried pipes. This may take quite a while, and the trap by-passes should be opened by hand, and kept open until they are all blowing steam freely.

Remember, when warming up a line, that the traps must be capable of removing the condensed water. Study any trap manufacturer's book for information on how much condensate is formed in a cold pipe when raising steam. You would do well not to overload your traps, since water hammer in a cold pipe can be destructive. Once hot, lines can be shut down for many hours without unduly cooling. During your try-out period, experiment with various cooling down periods, watch to see when condensate starts to become a problem.

If your draft blowers are fitted with inlet and outlet dampers, should both sets of dampers be operated together or one at a time? Consult the fan manufacturer for his recommendations. A good practice, at low loads, is to set the discharge dampers at a partially open position, and control the fans with the intake dampers only. Depending on your fan and its characteristics, you can get many different modes of operation.

If you have an induced draft stack fan, and a forced draft blower, which should you shut off in case of low loads? One way is to keep the stack fan going, and regulate the firebox pressures by adjusting the forced draft fan dampers, even though the fan is shut off. Usually, if the stack fan is shut down, and the forced draft fans run, combustion gases will leak out of the furnace into the boiler room.

Can you run at low loads without using fans or blowers? Yes, you probably can, but beware of instability or "panting." You can blow up the firebox with such a condition. If such instability is a problem, putting orifices in the controller pipelines may slow up an overcontrol condition. Try to keep your firebox pressures at a minimum and yet provide draft up the stack.

What combination of burners should you use? This is determined by experience; but the heat should be evenly distributed. Try to keep all your atomizer tips the same size so they will atomize equally on the fuel pressure existing in the fuel oil header. If you use steam atomization, keep the pressure at the minimum for good combustion. The atomizers can waste a lot of steam. Adjust the burner position so the flame will not impinge on the burner cone, but yet will not be so far out from the cone that air will not mix properly with the fuel.

Watch for carbon build-up on your burners. Excessive build-up will indicate inefficient combustion. Beware of dripping burners, since they will pile up pools of oil on the furnace floor. Be suspicious if your instruments suddenly start to edge away from normal, or if you have to make continual adjustments of any control in one direction, without a corresponding change in load.

Learn the characteristics of all your operating conditions. Watch temperatures, pressures, flows, and plot them against efficiency, so that eventually you'll be easily able to spot malfunctions, and so you'll be able to pick your most efficient operating conditions.

The Chemical Angle

Feedwater treatment is an essential part of your operation. By proper treatment you can minimize corrosion, scale deposits, blowdown losses, carryover, and foaming. Testing and treatment must be carried on consistently and regularly. When you consider that a small boiler may evaporate 1,000,000 lb of water daily, a 15 ppm impurity content means

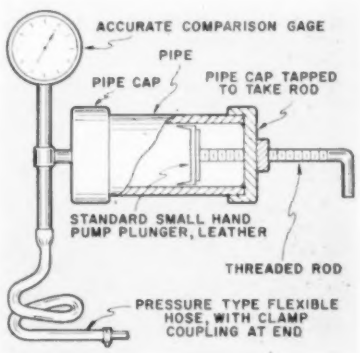

ACCURATE COMPARISON GAGE
PIPE
PIPE CAP
PIPE CAP TAPPED TO TAKE ROD
STANDARD SMALL HAND PUMP PLUNGER, LEATHER
THREADED ROD
PRESSURE TYPE FLEXIBLE HOSE, WITH CLAMP COUPLING AT END

Fig. 1. Simple test device for setting pressure switches, testing gages. To use, fill with water and connect rubber hose to equipment. Screw down plunger rod, check pressure on gage

Fig. 2. Train your operators to use automatic controls and instruments. Such controls are indispensable to efficiency

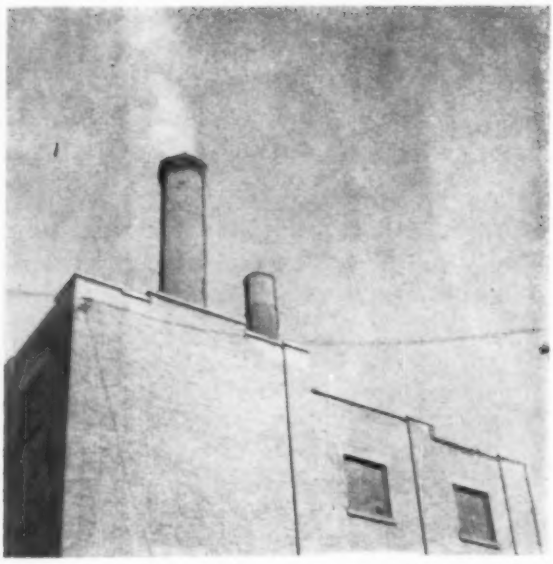


Fig. 3. Try to run your furnace so that stack gas analysis shows highest possible CO_2. This means thin haze at stack

15 lb of sludge or scale deposited in your boiler daily.

The most convenient way to plan treatment is to call in engineers from several water treatment firms. They will analyze your water and recommend suitable treatment. Do not neglect to protect your condensate lines against CO_2 corrosion at this time.

The tests which are applied daily to control feedwater treatment can be performed by an efficient operator in about 20 minutes. The test equipment should cost less than $100. Do not let well-meaning advisers tell you that a shot of soda ash will solve your boiler treatment problems. The "once a day, guess the amount" type of treatment will, in the end, cost you more in repairs, inconvenience and downtime than proper treatment. Whatever treatment you decide to use, be sure that it's in line with the basic tried and true principles of filtration, ion-exchange and chemical removal.

Incidentally, any change in treatment may release quantities of scale and deposits. Don't take this as an absolute proof that the new treatment is better than the old. Proceed carefully when changing treatments, or when starting treatment on an old boiler, since, if the scale is removed too rapidly, it will cause trouble in the system.

Purchasing Fuel

Fuel purchases should be made primarily on the Btu per dollar valuation. This, of course, includes such factors as performance of fuel, heating value, effect of impurities, and delivery conditions. Unless you buy an extremely large quantity at one time, fuel cannot be bought exactly to your desired specifications. Therefore, it is best to obtain samples of whatever fuel you buy and have a chemical analysis made of this fuel by a reliable chemical analysis firm. Then, should your fuel not be satisfactory, or should you have other sources available, the chemical analysis which was made will serve as a comparison basis for fuel which you might obtain from some other sources.

In addition, by correlating the effect of the fuel which you are using with the chemical analysis, you will be able to establish your own specifications for fuel to serve your purpose best. Assuming, for instance, that you have had trouble with excessive water in the system, then the next lot of fuel for which you contract should have in the purchase order a water content specification based on the previous analysis.

One of the important considerations to keep in mind when purchasing fuel is that probably you are billed for fuel oil at 60 F. The oil, however, is usually delivered at some elevated temperature, possibly in the vicinity of 140 to 180 F. It is obvious therefore, that unless some correction is made for the elevated temperature of the fuel which is delivered, you are receiving less fuel than you are paying for. Be sure that when you are billed for fuel, a correction is made for the variation due to temperature conditions.

The usual considerations when buying fuel oil are the heating value in Btu per gallon, and the density. These two figures should be considered together, since obviously the Btu per gallon is not a true criterion of the heating value per lb, especially in the case of extremely light oil. The true measure is Btu per lb. Delivery temperatures should be noted at each delivery. Calorific values and temperature corrections are to be found in Bureau of Standards, U. S. Department of Commerce, Circular C410.

Flash point is important in that it is undesirable to have a flash point so low that it will introduce undesirable hazards into your plant or so high a point that atomization is difficult. Viscosity is a measure of the pumping power and of the heating which will be required to burn the oil.

Water which is present in all fuel oils in some degree is undesirable, inasmuch as it will settle out in the bottom of the tanks and cause corrosion. If your fuel oil has large amounts of water in it, it might be good practice to drain the tanks at regular intervals and draw off the water.

Sediment is another item which contaminates the usual fuel oils, and whether combustible or non-combustible, it will lead to trouble with clogging of the various parts of the fuel oil burner system, and to sludging up the tanks.

Other chemical impurities, especially sulphur, are undesirable since they introduce corrosion and do not greatly contribute to the heating value of the fuel. The ash content is important in that it is a non-combustible material which will either be deposited on the boiler tubes or will be blown out the stack as smoke.

Common types of fuel oils are: No. 6, which is medium-heavy oil; No. 5, which is a lighter, more purified version of No. 6; and No. 3, which is a light distillate similar to kerosene and diesel oil. Number 3 oil can be burned without preheating and can be used for light-off or start-up operations. Numbers 5 and 6 fuel oils will require preheating for proper combustion.

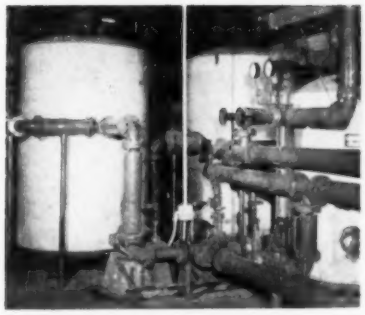


Fig. 4. Feedwater treatment means daily testing. Be sure you choose a treatment based on tested principles

Under certain circumstances it may be desirable to mix No. 3 with heavier oils for certain specified plant conditions, as when the fuel oil heaters are not operating properly. If you plan to let your plant get cold, see that you have some No. 3 oil in your tanks, and that you have a set of cold starting tips.

Fuel oil additives are used to reduce viscosity, to emulsify water and to provide a certain degree of "burnability." Although there are several different types of fuel oil additives on the market, you can make your own test of the value of each of these by mixing representative samples of your fuel oil with a specific brand of fuel oil additive. It is important to note that the true cost of the fuel oil additive will not only lie in the chemical properties, but in the cost when using the recommended proportions.

If two equally desirable fuel oil additives are sold at the same price, obviously the cheaper is the one that will do the job in the lower concentration. Therefore, when considering additives, sample mixtures should be made up in the concentration in which it would be normally used in your system. This might be on the order of a few drops per quart.

The ideal fuel oil additive will be perfectly neutral, that is, neither alkali nor acidic, with the passage of time. It can easily be checked by testing the mixed sample with litmus paper from time to time. It should not separate out, should burn easily, and reduce viscosity. The reduction in viscosity can be observed either by use of a viscometer, or by allowing a specified amount of the sample to drip through an extremely small hole in a container. A sample of fuel oil additive which takes longer to drip through is of course the one which is harder to pump.

The last requirement which we should check by using the samples, is the ability to emulsify water in the proportions we plan to use. Since it is hard to observe water in the small amounts of fuel oil used for samples, it may be well to add several teaspoons of water to each of the samples and observe which bottle will absorb the most water without settling out.

Coal-fired installations should use the same general approach to ordering and burning coal as is recommended for the fuel oil plants. Coal should be ordered on the basis of heat value per dollar, and 250- to 1000-lb samples should be submitted for analysis. A proximate analysis of the sample is the cheapest and quickest to make and will be adequate for the purpose of a small plant. When buying the coal it is important to note whether it is wet or dry; and a very important consideration involves not only the ash content but the temperature at which the ash will fuse.

It is difficult for the small plant to set up adequate specifications for fuel purchase; but by obtaining analysis of the first lots of fuel, the undesirable characteristics of such fuels can be weeded out, by making later purchases to some degree of specification. In any case, intelligent operation can minimize the effect of undesirable elements.

Operating Economy

Operating economy is the reason why we buy new and improved equipment, and hire and train top crews. The ideal plant is not a 100 per cent efficient plant, since mechanical losses creep in, but let us call a plant "ideal" which is operated to the maximum of its theoretical efficiency.

If a boiler is 80 per cent efficient, then 80 per cent of the oil Btu being used should appear as steam. Is this right? Not always — we have leaks, plant uses, losses in heat radiation, and so on. However, correct and intelligent operation will minimize these losses.

An important loss is due to the fact that, in order to secure adequate air for proper combustion, we must supply an excess of about 20 per cent. This excess air is simply heated and discharged through the stack. We must, therefore, keep the excess air at a minimum, and the stack temperature down as much as possible.

Stack temperature on a new boiler will be a certain number of degrees over the steam temperature. Know this figure, and look for trouble if this difference changes. Dirty boiler tubes or excess air will raise the stack temperature. This can be a quick check on operating conditions. Some plants still blow tubes on the basis of a rise in stack temperature.

Depending on the ratio of C to H_2 in your fuel, the ideal percentage of CO_2 in your stack gases may vary between 14 and 19 per cent. Try to run your furnace so that stack gas analysis will show you the highest possible CO_2 percentage. In practice, this will be just at the point where a thin haze begins to show from the stack. Keep your smoke indicator properly adjusted so you will not cause smoke and bring the smoke inspector to your door!

In operation, then, carefully watch the stack temperature, and smoke, or lack of smoke, the CO_2 meter reading, the fuel oil temperature, the oil pressure at the burners, and the atomizing steam (if any). Don't try for the clear stack — that's easy. Try for the haze. Most handbooks will have charts which can be used to relate CO_2, stack temperature, excess air, and efficiency. Some of the portable CO_2 analyses have a slide rule to work out this problem.

Feedwater and fuel oil temperatures should be watched. The feedwater temperature is usually governed by your equipment, but keep it as hot as you can.

The oil temperature is adjustable, and is set as necessary. Too high a temperature will cake up your heaters and cause flaking, while too low a temperature will not burn and atomize properly. The Navy recommends as an optimum burning temperature that at which the fuel oil viscosity is 135 S.S.U. So get out your fuel oil tables and set the heaters to give you this value!

Your operators are the guardians of efficient operation. Can they be trusted to give 100 per cent attention all the time to correct for small variations in the load, or in the operating conditions? No, for even if they are good men, they may be busy elsewhere, or they may not be able to keep up with continuous adjustment.

Automatic controls, however, if used, are tireless, continually responsive, and sensitive. Instruments when properly interpreted give indications of changes before an operator can notice any difference. Train your operators to use automatic controls and instruments. There's many a plant with jammed draft gages, frozen CO_2 indicators, inoperative smoke meters. Don't let this happen to your plant. "Sure," some engineers will say, "automatic controls are nice to have, but they're a lot of trouble. I can do okay without them." This engineer is probably the fellow whose boiler just boils, and very little else!

A few more necessary organizational details should be called to your attention now. Prepare for possible emergencies by training your crew, by discussion and study. Lose steam — what to do? Fires out and boiler cold — how to start from a cold boiler room? Blowout somewhere? Feed pump conks out? Anticipate such emergencies by some advance study.

Insurance and boiler inspection are necessary and should be routinely accepted. The insurance inspector can give you much help. Maintain your plant at all times so that no criticism will be leveled at you (you'll get plenty, anyhow).

Finally, remember that insurance and state boiler codes govern any significant changes in your plant systems. These may be based on ASME codes, so keep informed of all the legal, sensible, and necessary requirements governing your operations and maintenance. THE END

In analyzing efficiency of performance for a power plant, the Carnot cycle will give the maximum efficiency for *any* heat engine. It's a theory-tool with which every operating engineer should be familiar. So here's a . . . . . .

Refresher Look at the Carnot Cycle

By J. H. POTTER *

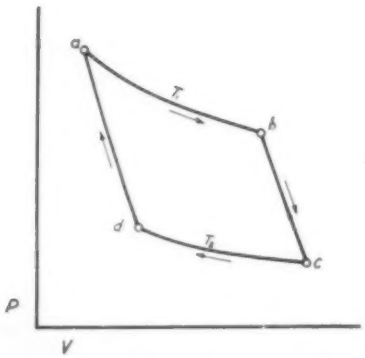


Fig. 1. Carnot cycle in the P-V plane, non-flow engine. Gas expands along ab

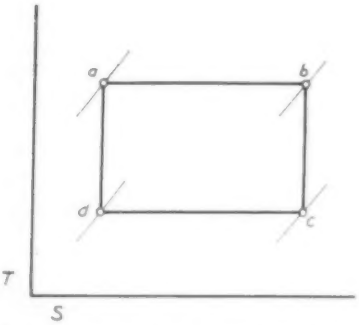


Fig. 2. T-S plane for the same cycle. Only heat added is in area under ab

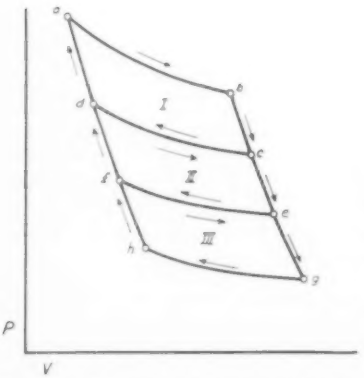


Fig. 3. Connecting Carnot cycles in cascade increases total work output

AFTER one and one-third centuries, the Carnot cycle stands as one of the greatest theoretical concepts of physical science. In this article, the cycle is reviewed in terms of non-flow and steady flow heat engines. The thermodynamic temperature scale, the theoretical regenerative boiler feedwater cycle, and the Gibbs-Helmholtz equation are shown as extensions or consequences of the Carnot cycle.

The concept of the perfect reversible cyclic heat engine, indeed the idea of thermodynamic reversibility itself, was the inspired work of one young man. Nicholas Leonard Sadi Carnot published his classic paper in 1824 when he was 28 years of age, and it is probable that the actual writing had been done four or five years earlier. Carnot grew up during the turbulent times of the French Directory and Empire, and followed his famous father in a military career. A scholar by nature, he interested himself in many areas of science and the arts. It is probable that he would have become one of the greatest of academicians but for his untimely death at the age of 36.

Appreciation of the importance of his work began when Lord Kelvin discovered the Carnot paper, analyzed the cycle, and pointed out some of the exciting corollaries. The original paper and a brief biography of Carnot were published in a recent special edition by the American Society of Mechanical Engineers, thus making all of the source material available in translation. An earlier ASME celebration marked the centennial of Carnot's great contributions. (See the references at the end of this article, for all these references.)

Nature of Carnot Cycle

Carnot clearly understood the importance of thermodynamic reversibility, and specified a closed cycle bounded by reversible paths. His explanation of the series of events occurring in the cycle required that the heat medium be confined in a cylinder which could alternately and instantaneously take on the character of either a perfect insulator or a perfect conductor.

In Fig. 1 a Carnot cycle is shown in the P-V plane, as it might be traced by a perfect gas enclosed in a cylinder with a frictionless piston. The gas expands along ab isothermally, requiring that the cylinder be a perfect conductor capable of transferring exactly the heat necessary to maintain constant temperature. Further expansion along bc is adiabatic and reversible, requiring the piston and cylinder to take on the properties of a perfect insulator. Compression is also in two steps: isothermal along cd, and isentropic along da, again requiring a perfect conduction and a perfect insulation respectively.

The T-S plane for the same cycle is shown in Fig. 2. Here it is evident that the only heat added to the cycle is represented by the area under ab; the only heat rejected by the area and under cd.

As a complete cycle has been traced along a series of reversible paths, the first law may be applied in the form:

$$\int dW = \int dQ \qquad 1.$$

This is equivalent to the statement that the net work done in the cycle may be represented by the area enclosed by abcd in either the P-V or T-S planes.

The thermal efficiency of the cycle is given by:

$$(Q-Q_r)/Q$$

but as heat addition and heat rejec-

Symbols used are identified below. For extensive properties, the specific, or per unit mass, quantities are used.

- F = Helmholtz function, U-TS
- Δ = Helmholtz free energy, Δ_F=TΔS
- P = pressure
- Q = heat added to cycle
- Q_r = heat rejected from cycle
- S = entropy
- T = absolute temperature
- U = internal energy
- V = volume
- W = work
- η = thermal efficiency = $(Q-Q_r)/Q$

* Professor of Mechanical Engineering, Stevens Institute of Technology

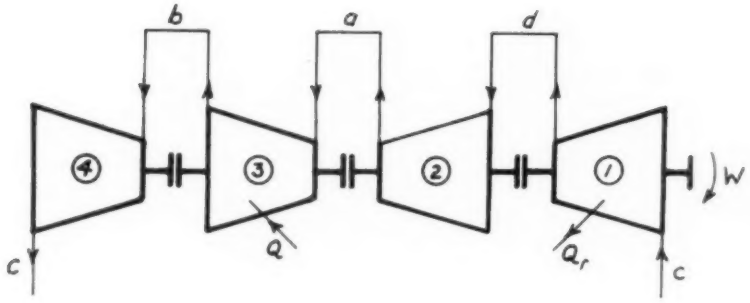


Fig. 4. Steady flow cycle using a perfect gas may be imagined in the "gas turbine" arrangement shown here. Gas enters compressor 1 at c, leaves at d

tion are each along isothermal paths:

$$\eta = \frac{Q - Q_r}{Q} = \frac{T_1 - T_2}{T_1} \qquad 2.$$

Carnot appreciated that high thermal efficiencies depended upon adding heat at the highest possible temperature and rejecting heat at the lowest possible temperature, a desideratum reflected in the development of steam power plant cycles ever since.

Although the actual thermal efficiency of a steam cycle is generally compared to that of a Rankine cycle, the Carnot cycle is an even more severe comparison test. Whereas the Rankine cycle reflects the performance of the turbine and steam generator, the Carnot cycle spans the generating equipment from the topmost superheat temperature (source) to that of the condenser cooling water (sink). Granted that modern power practice favors heat rate as a measure of performance, a good case could still be made for the Carnot cycle as a basis of comparison.

One of the corollaries of the second law of thermodynamics is that no engine operating between two isothermal reservoirs can have an efficiency greater than that of a reversible engine. By the same logic one may prove that no reversible engine is more efficient than any other reversible engine. Engineers sometimes lose sight of this second idea, and seem surprised to find that a Stirling or Ericsson cycle can have the same theoretical efficiency as the Carnot cycle.

Lord Kelvin appreciated that any property dependent solely upon temperature could be used to establish a temperature scale. Accordingly he proposed that the Carnot cycle be the basis of a new thermodynamic temperature scale, in which the temperatures would be proportional to the heat addition and rejection. By definition:

$$\frac{\Theta_1}{\Theta_2} = \frac{Q_1}{Q_2} \qquad 3.$$

where Θ is the temperature on an arbitrary thermodynamic scale.

In Fig. 3 (preceding page) a series of Carnot cycles is shown connected in cascade.

Heat rejected from I becomes the heat added in II, and the heat absorbed in III is that rejected from II. As more and more cycles are added, the total work output is increased. In the limit, the lowest cycle rejects heat at a temperature approaching but never attaining absolute zero temperature. In the use of the Carnot cycle to define a temperature scale, Kelvin obviated the need for a temperature scale based upon the expansive properties of a thermometric medium.

While it is customary to present the Carnot cycle as an imaginary non-flow heat engine, the theory may also be developed with ideal steady flow machines. In fact, the latter approach has the advantage that there are no unique requirements for the confining vessel, such as the alternate changes from perfect conductor to perfect insulator specified in the non-flow development.

A steady flow cycle using a perfect gas may be imagined in the "gas turbine" type of arrangement shown in Fig. 4. Here the gas enters the isothermal compressor, 1, at c and leaves at d, having been cooled during compression by an amount Q_r. Further pressure increase is effected in the isentropic compressor, 2. Expansion is initiated in the isothermal turbine, 3, in which heat is added in the amount Q. Final expansion is isentropic in turbine, 4. In the T-S plane this series of operations is as shown in Fig. 2.

The Carnot cycle is independent of the heat medium used. Likewise it is independent of phase changes in a given medium. An imaginary steam power cycle is shown in Fig. 5. Here heat, Q, is added in just sufficient amount to vaporize the water in the boiler, 1. The turbine, 2, provides isentropic expansion of the dry saturated steam from b to c. In the "semi-condenser", 3, heat is removed in the amount Q_r, reducing the quality of the exhaust steam without completely condensing it. A vapor compressor, 4, takes the low pressure steam at d and provides isentropic compression back to the saturated liquid condition at the boiler. Net work, W, is removed from the cycle in an amount equal to $(Q - Q_r)$. The steady flow cycle just described is bounded by the four reversible paths defining the Carnot cycle. The corresponding T-S plane is shown in Fig. 6.

The Carnot engine may be run reversed, in which case it becomes a refrigerating machine. A theoretical engine to operate on a reversed Carnot cycle is shown in Fig. 7, in which the compressor and expander are represented as reciprocating engines. For the particular illustration chosen, the T-S plane will be the same as it was in the steam power cycle, Fig. 6, save that the direction of the squence of steps will be reversed.

Liquid refrigerant, a, enters the expander, 1, where the pressure is reduced isentropically to the lower temperature level at d. The cold, low pressure fluid, d, enters the evaporator, 2, where it absorbs heat from surroundings. In the evaporator the quality of the low-pressure refriger-

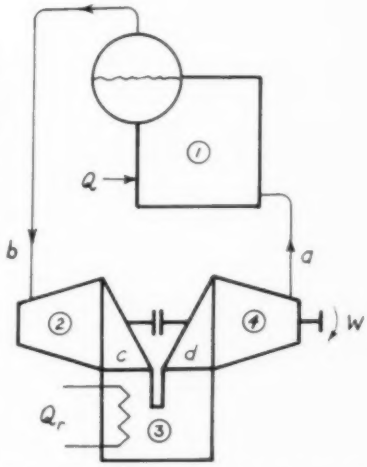


Fig. 5. Carnot cycle is independent of heat medium used. This shows steam power

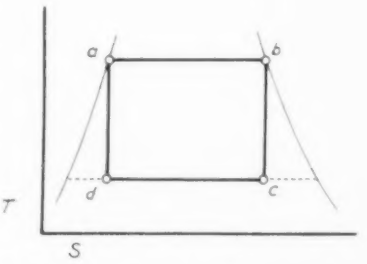


Fig. 6. Carnot cycle in T-S plane for the vapor steady flow cycle of Fig. 5

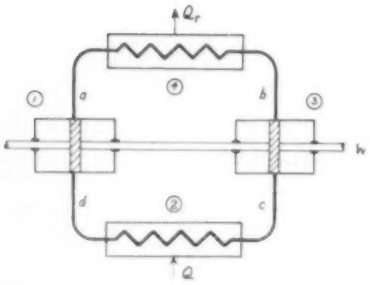


Fig. 7. Carnot engine may be reversed thus becoming a refrigerating machine. Refrigerant enters expander 1. Evaporator is 2, compressor 3, condenser 4

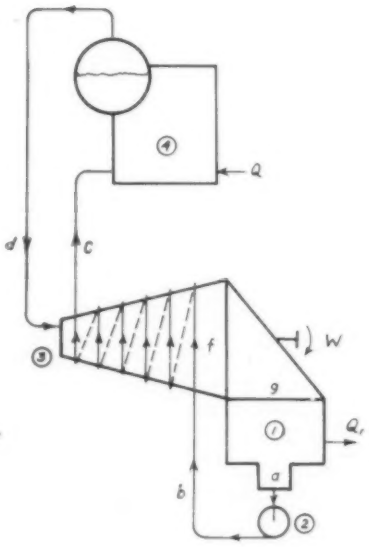


Fig. 8. Theoretical regenerative feedwater heating cycle. Condenser is at 1, isentropic feed pump at 2, turbine at 3, boiler at 4, heat of vaporization Q

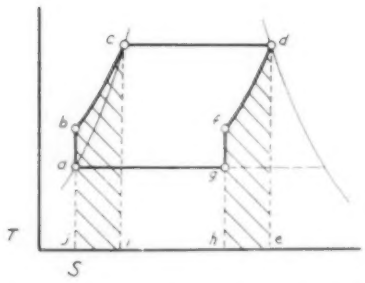


Fig. 9. Regenerative paths in the T-S plane of the cycle described in Fig. 8. Equation 2 shows that such a cycle will have same efficiency as Carnot cycle

ant is increased from d to c, but complete vaporization does not take place. The compressor, 3, raises the pressure of the refrigerant isentropically to b, corresponding to the saturated vapor state at the upper temperature limit. Heat is removed isothermally in the condenser, 4, completing the cycle. The net work, W, will be negative, or in other words work must be supplied to the system to make it operate as a refrigerating machine.

Another interesting theoretical cycle is shown in Fig. 8. Here a steam turbine generator unit is supplied with dry saturated steam. The boiler adds only the heat of vaporization, as the feedwater has been brought up to saturation temperature in a theoretically perfect regenerative heating system. The condenser, 1, receives wet steam at g, removes heat Q_r, and discharges saturated liquid at a. The isentropic feed pump, 2, raises the pressure to b, the saturation pressure in the boiler drum.

Water leaving the feed pump passes through a long frictionless pipe made from a material having perfect heat transfer properties, and coiled around the shell of the steam turbine. During the passage of the water through the coil, heat is absorbed from the steam which is being expanded inside the turbine. In Fig. 9 the corresponding T-S diagram is shown; the heat added to the feedwater is represented by the shaded area, bcij.

The heat of vaporization, Q, is added between c and d in the boiler, 4. The steam enters the turbine, 3, at d, and is simultaneously expanded and cooled up to a point, f, near the end of the expansion. In Fig. 9 the heat given up by the steam to the feedwater is represented by the shaded area, fdeh. The path df is exactly parallel to the path cb, and at any given time perfect counter flow heat transfer conditions obtain. The last part of the expansion in the turbine is isentropic, the path fg being parallel to the isentropic compression of the feedwater along path ab.

From Fig. 9 it is apparent that a cycle has been devised in which there is only reversible heat addition along the isothermal path cd, and only reversible heat rejection along the isothermal path ga, and that the entropy change is identically the same for each path. From equation 2 it is seen that such a cycle will have the same efficiency as a Carnot cycle.

In the literature of physical chemistry the Carnot cycle is sometimes used as part of a more complicated thermodynamic proof. A point in case is the very important Gibbs-Helmholtz equation, from which Nernst derived the third law of thermodynamics (see bibliography).

For a Carnot cycle:

$$W = Q_\eta = Q\left[\frac{T_1 - T_2}{T_1}\right] \qquad 4.$$

In the special case where heat is added at temperature, T, and rejected at (T — dT):

$$\delta W = Q\left[\frac{dT}{T}\right] \qquad 5.$$

The first law of thermodynamics may be written in either the differential or integrated forms:

$$\delta Q = dU + \delta W \qquad 6.$$

$$Q = \Delta U + W = T\Delta S \qquad 7.$$

Combining 5 and 7,

$$Q = \left(\frac{\delta W}{dT}\right)T = \Delta U + W \qquad 8.$$

By definition:

$$F = U - TS \qquad 9.$$

For an isothermal change,

$$\Delta F = \Delta U - T\Delta S \qquad 10.$$

$$T\Delta S = -\Delta F + \Delta U$$

Equation 7 transposed becomes,

$$T\Delta S = \Delta U + W \qquad 11.$$

which is equal to equation 10. It is evident that for a non-flow, isothermal process the maximum work is equal to the decrease in the Helmholtz free energy, or

$$W = -\Delta F \qquad 12.$$

Transposing 8 and combining with 12 gives the Gibbs-Helmholtz equation:

$$\Delta F - \Delta U = \left(\frac{d(\Delta F)}{dT}\right)T \qquad 13.$$

Conclusions

1. The thermodynamically reversible heat engine, with the attendant corollaries, was one of the greatest physical concepts developed during the nineteenth century.

2. The Carnot cycle, bounded by two isothermal and two isentropic paths, is only one of many theoretically reversible cycles each having the same efficiency.

3. In the theoretical regenerative feedwater heating cycle, Carnot cycle efficiency can be realized.

4. The thermodynamic temperature scale is perhaps the most widely used application of the Carnot cycle.

5. The thermal efficiency of the Carnot cycle may be used as a standard of comparison for the thermal efficiencies of real heat engines.

6. The Carnot cycle has found some application in the development of some of the equations used in physical chemistry. THE END

REFERENCES

1. Reflexions sur la Puissance Motrice du Feu, by S. Carnot. Chez. Bachelier, 1824.
2. Account of Carnot's Theory of the Motive Power of Heat, by Sir William Thomson. Transactions, Royal Society of Edinburgh, vol. XVI, 1849.
3. Reflections on the Motive Power of Heat, by S. Carnot. Translated by R. H. Thurston. American Society of Mechanical Engineers, 1943.
4. The Carnot Centenary Comemoration. *Mechanical Engineering*, vol. 47, 1925, pages 37–40.
5. The Nernst Memorial Lecture, by J. R. Partington. *Journal of the Chemical Society*, Sept. 1953, pages 2853–2872.

Refrigeration Lesson—Watch That Greasing Job

By C. T. BAKER

EARLY IN 1955, the larger of two freezing tanks in a 75-ton ice plant began to drop in output. Since full capacity was not needed at the time little thought was given the matter.

However, some 18 months later the problem became serious because of an unusual and unexpected demand for refrigerator car icing. Before the car icing season closed, considerable ice had to be purchased from a competing plant.

Capacity of the freezing tank was 55 tons per day. It was fitted with a large single pass shell and tube brine cooler. Only one of the three compressors in the plant operated on this cooler.

Search for the cause of failure to perform disclosed some interesting facts. For example: there was an almost continuous carry-over of liquid ammonia from the shell cooler to the compressor; the discharge pipe between the compressor and condenser was cold most of the time; the tank temperatures remained too high to permit normal ice harvesting.

A single vertical propeller driven by a $7\frac{1}{2}$-hp motor circulated brine through the tubes of the cooler and between the rows of 400-lb capacity ice cans. Cup grease was used to lubricate a shaft bearing located below the lower end on the driving motor. A grease pressure gun was used to force the lubricant into the bearing.

Not much judgment was used by the man whose job it was to keep the bearing supplied with grease. He applied the lubricant at least twice each week, regardless. In using the hand pump to force the lubricant into the small bearing, it was the practice to force all possible grease into the bearing and then allow a liberal amount to escape and fall on the cast iron plate that supported the agitator assembly.

Over a period of years much of the heavy grease that was deposited on the supporting plate found its way into the brine below and then into the tubes, where it remained. Since there was considerable fine dirt suspended in the brine, much of this foreign material mixed with the cup grease, making a sticky paste that would not dislodge from the tubes, which meant that the tank had to be emptied of brine and the tubes scraped manually.

After the tank and tubes had been cleaned, the brine was filtered to remove grease and dirt and then replaced in the tank, after which additional calcium chloride brine was added to bring the brine level to the proper height in the tank.

When placed back in service, the tank produced the rated output of ice. Incidentally, a greatly modified schedule of lubricating the bearing of the propeller was put into effect and provision made to prevent loose grease from getting into the tank.

It is evident that with the cooler tubes coated on the brine side with a material ranking high in the scale of non-conducting materials, it was most difficult for the cooler to give up its heat to the ammonia.

Here is a case where ignorance, laziness or indifference on the part of those in charge of plant operations allowed unfortunate conditions to exist and build up trouble over a long period of time.

Economy Fuels Cut Costs at Ipswich Power Plant

USE OF two economy fuels in six of seven Fairbanks-Morse diesels has enabled the municipal power plant in Ipswich, Mass., to generate a kwh at a fuel cost of more than 40 per cent below the cost with No. 2 diesel oil.

Through 1953, the plant used No. 2 diesel fuel exclusively. In 1954 a dual fuel engine began to utilize a newly available supply of natural gas. Subsequently, a decision was made to supplement those fuels with processed crankcase drainage and the plant began to use this heavy oil in 1956. The result is a combination of the use of all three classes of fuel, with very satisfactory results.

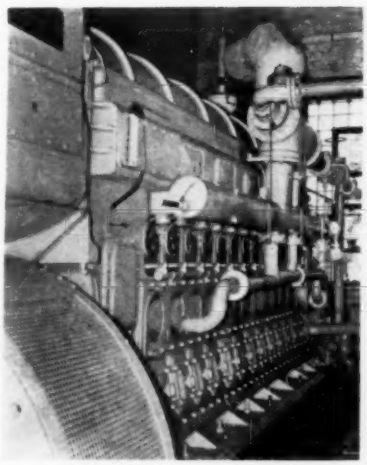
Saving through burning economy fuels is estimated at $45,667 for 1956; and in the first half of 1957, doubling the use of crankcase drainage reduced the liquid fuel cost by $12,000.

Four of the engines burn heavy fuel and use No. 2 for starting. The fifth unit burns either heavy fuel or gas with No. 2 used as pilot oil. The sixth engine burns gas and No. 2 as pilot oil. Now only the oldest engine in the plant is restricted to use of No. 2 fuel and this unit is retained as a standby.

The newest engine, a 1920-hp model 38D8$\frac{1}{8}$, Fairbanks-Morse opposed-piston diesel, employs high temperature cooling, a feature of considerable importance in the use of heavy fuels. With a small modification of the system for burning crankcase drainage, all the engines now using heavy fuel could burn commercially available residuals. Transition to the use of economy fuels has been made without interruption of power and with no apparent increase in the cost of maintenance.

In 1956, the plant used about 200,000 gal of treated crankcase drainage at a cost of 7.1 cents per gal. The liquid fuel, both No. 2 and crankcase drainage, totaled 708,334 gal at a cost of $76,924. No. 2 fuel, costing 12.33 cents a gal, would have cost $87,337.58, or $10,413.58 more for the year. Gas consumption was stepped up to 93,391 mcf and the total fuel cost for the year was $123,619 to generate 17,272,400 kwh.

As a result of progressive engineering improvement, by taking advantage of higher thermal efficiency of later engine models, and now by using low cost fuels, Ipswich has had no increase in electric rates during the past 25 years. It is estimated that the town saves $35,000 a year on electric bills. Also, the plant pays $15,000 a year into the town treasury out of operating profits.



Newest diesel at Ipswich plant was installed in 1957, has high temperature cooling. It burns crankcase drainage with No. 2 fuel for starting, is connected to an exhaust silencer-boiler

New Equipment Automatically Analyzes Water and Controls Treatment

Colorimetric Analyzers introduced to power field provide continuous automatic control for demineralizers and boiler water treatment

By GEORGE SCHNEIDER *

ALONG WITH the design changes in power plants to use higher steam generating temperatures and pressures, there have been necessary changes in boiler water treatment. The newer plants require higher quality water with an absolute minimum of dissolved, scale-producing compounds, including silica. Fortunately, the development of demineralizers and water softeners has kept pace with the need for better water treating facilities, and it is possible to provide modern boilers with the necessary high purity water. Also, it is possible to treat the water automatically up to a point.

Until recently, however, there has been no primary method for continuously measuring water hardness or silica content so that demineralizers can automatically regenerate in accordance with silica break-through. A typical *automatic* demineralizer had a conductivity recorder that detected any increase in dissolved solids at the middle of a bed and then rang an alarm or flashed a light.

At the signal, it was up to the operator to run laboratory analyses for silica and regenerate the demineralizer when silica started to break through. This method, of course, assumed conductivity broke in the middle of the bed before silica broke through the bottom of the bed. Not only did the silica analyses require the time and attention of an operator, but the analysis techniques were complicated and employed rather delicate laboratory apparatus. The apparatus was expensive and did not meet specifications for ruggedness and durability as other equipment with which operators are familiar.

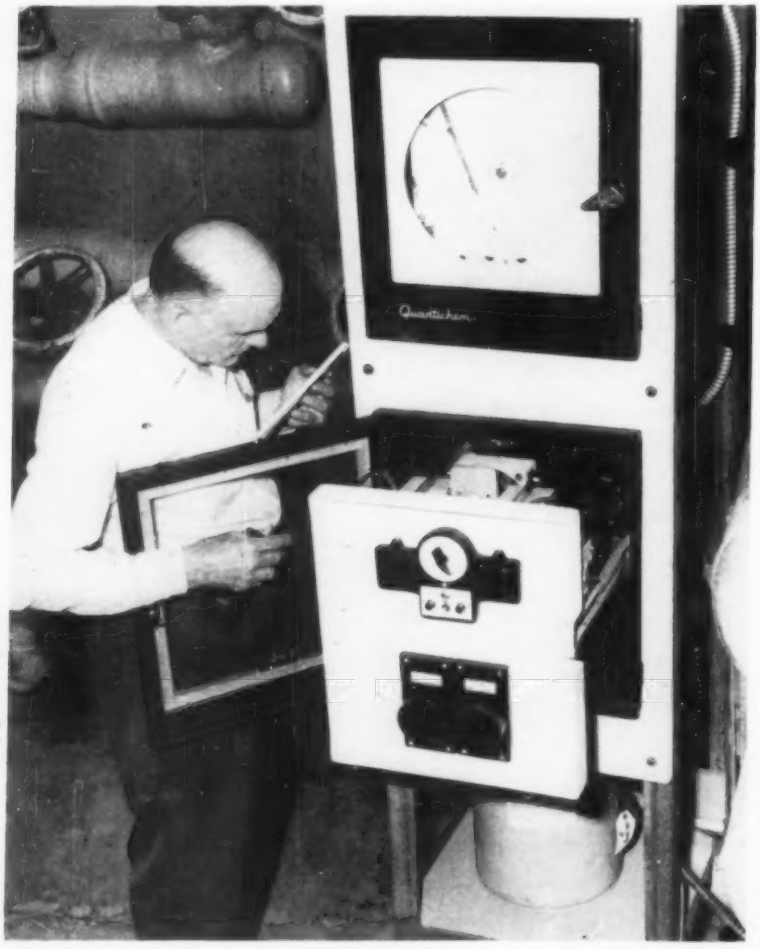


Fig. 1. A continuous automatic hardness analyzer installed in the power plant of a midwest oil refinery is used to keep a constant check on boiler make-up water

Miniature Analyses Laboratories

To meet this need for a rugged, accurate instrument which would continuously measure silica content and automatically initiate regeneration of a demineralizer or softener, one manufacturer spent three years in developing and field testing their colorimetric analyzers. These instruments are now installed in industrial power plants (Fig. 1) where they are measuring and recording total hardness of softener effluents or silica concentrations of demineralizer effluents. Basically these analyzers are miniature laboratories which automatically perform all steps of an analysis from flushing the sample cells to recording the results. The hardness analyzer makes a complete analysis every six minutes and the silica analyzer operates on a 12-minute cycle.

In a typical analysis the sample cells are flushed and drained. Then they are filled with metered samples of demineralizer or softener effluent, and the instrument automatically standardizes itself. Then chemical reagents are metered to the cells and the difference in light transmittance between the *zero* cell and the sample cell is measured by photoelectric tubes in a modified Wheatstone bridge circuit. The resulting signal is recorded on a chart calibrated in terms of concentration. Finally, the cells are drained and the cycle is repeated.

Operates on Beer-Lambert Law

The instruments are colorimetric analyzers based on an application of the Beer-Lambert Law. Simply stated, this law of physical chemistry says that if light of a given intensity and wave length shines through two samples of colored solutions for equal distances, the difference in the intensities of light emerging from the solutions will be proportional to the difference in the concentrations of the coloring agent in the solutions. To apply this law, the analyzers pre-

*Mgr of Research and Development, Suncoast Instrument Div, Milton Roy Co

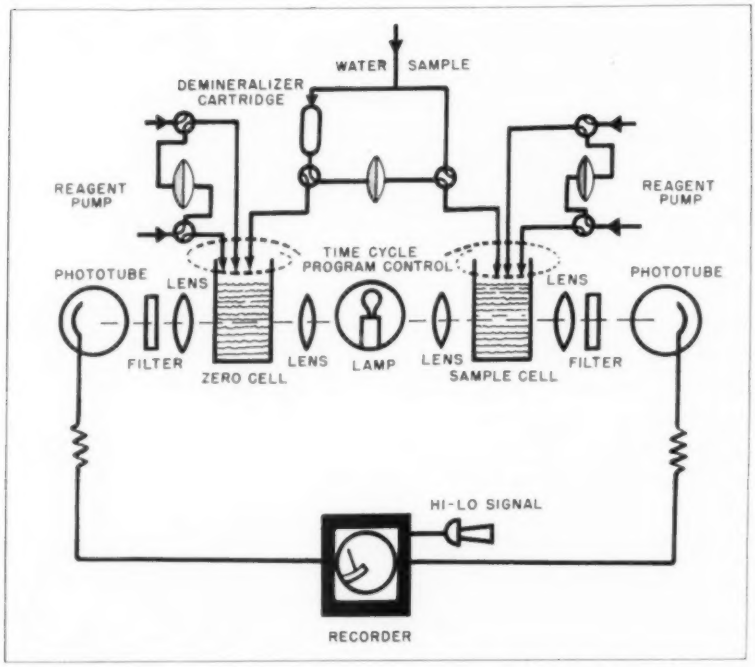


Fig. 2. Colorimetric analyzers are miniature laboratories which perform all steps of an analysis from flushing the sample cells to recording the results automatically

pare two solutions. One solution in the zero cell develops a color equivalent to a dye solution with no hardness producing ions or silica. This is accomplished by passing the *zero* sample through a small demineralizer. The *zero* sample then has no hardness or silica content that can react with the reagents that are metered in like amounts to both samples. Then according to the Beer-Lambert Law, the measurement of the difference in light intensities emerging from the two cells is equivalent to the concentration of the specific ion creating the color in the sample cell.

In theory this colorimetric technique can be used to analyze continuously any substance, but problems arise in putting theory into practice. First of all, it is necessary to determine chemical reactions in which the specific substance to be measured will cause a sufficient change without other substances interfering or clouding the solutions. Then when the color changes that will occur in the analysis for a specific substance are known, it is necessary to determine the wave length of light that will give the best accuracy for the range of concentrations to be measured.

Analyzers now in use will analyze for silica or total hardness. Manufacturer's research engineers are already working on analyzers for dissolved phosphates, iron and oxygen. Undoubtedly, these instruments will be used for other analyses as quickly as the chemical and optical problems are solved.

The light source in the analyzers is a high intensity light bulb. Optical filters between the light source and the photoelectric tubes screen out light of all wave lengths except light of the specific wave length most affected by the color change. Since the same light source is used for the *zero* cell and the sample cell, no errors are introduced into the measuring circuit due to different aging characteristics of two separate light sources. In addition, the glass windows of the cells are shuttered to prevent errors from lights outside the instrument.

Armour Foundation Method Used

Silica analysis is based on a method developed by the Armour Research Foundation. Four specific reagents are metered to the two samples in the cells. They are accurately metered by special pumps, through motor-controlled four-way valves, operating on a programmed cycle to allow sufficient time for reactions to take place.

The first reagent is a buffer solution which maintains the pH at the optimum for the reaction to follow. The second reagent is ammonium molybate, which reacts with silica and phosphorous to form heteropoly-molybdic acids. The third reagent added to each sample cell attacks the phospho-molybdic acid and decomposes it. It has no effect on the silicomolybdic acid. Thus after the third reagent is added, the only complex acid remaining in solution is the silico-molybdic acid.

Fourth chemical to be metered to the sample cells is a reducing agent that reacts with the silicomolybdic acid to form colloidal molybdenum blue. Excess chemicals are metered to the sample cells so that this reaction always goes to completion. It is the concentration of molybdenum blue that determines the intensity of the light emerging from the sample cell, but the concentration of the molybdenum blue in turn is exactly equivalent to the concentration of the silica in the water tested.

Hardness analyzer uses but one reagent which contains the dye and buffer. The dye changes color in accordance with the concentration of the calcium and magnesium ions in the water. Again, a deionizer is used so that there is no calcium or magnesium in the *zero* cell. The deionizer cartridge has an expected life of two years but should be replaced after six months of operation for best results.

Uses Wheatstone Bridge Circuit

The analyzers have Wheatstone bridge circuits to transduce the difference in light intensity to a movement of the recording pen. The two phototubes are variable resistances in the bridge. Small d-c signals resulting from an unbalance in the bridge circuit, when the intensities of light reaching the phototubes differ, flow through a chopper which converts them to a-c signals. All the a-c signals are amplified and become correction signals for the balancing motor which moves a slidewire positioner in the correction direction to rebalance the bridge circuit. Simultaneously, it moves the recording pen to a new position indicative of the results of the analysis. The slidewire potentiometer is of the single turn precision type with a linearity of plus or minus 0.1 per cent.

Programming Unit Functioning

The entire program for an analysis is established through a commutator plate. A timer sweeps an arm of small wipers around the plate to make the necessary electrical circuits. A dial on the front of the analyzer shows the progress of the program which can be changed manually if desired. Also the operator can stop the program at any stage to check the equipment.

During the standardizing portion of the program, if there is too much dirt on the cells and the Wheatstone bridge circuit can't be balanced, a small light signals the operator that the cells must be cleaned. A second light on the analyzer signals the operator whenever the light source is too dim and must be replaced. Tests have shown that the analyzers will have less than ten per cent drift in 24 hours without standardization; nevertheless, they automatically standardize at the beginning of each cycle.

Special controlled-volume pumps are used to meter the samples and the reagents. These pumps have two chambers separated by diaphragms. Through the programming of four-way valves, a reagent flowing into one side of the pump forces an exact equivalent amount of liquid out of the opposite side of the pump. When the four-way *continued on page 110*

How to Use the Germanium Rectifier

By A. L. DIVENUTI, JR *

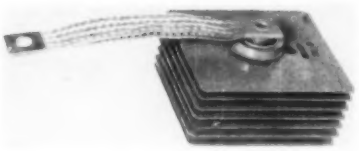


Fig. 1. Germanium rectifier Type 6RA14

GERMANIUM RECTIFIERS, first developed by the General Electric Co in 1950, are commanding greater attention as a result of process improvements, better packaging methods, and a more complete understanding of their inherent characteristics and limitations.

More than 80,000 kw of power have been installed by General Electric in applications such as electroplating, anodizing, copper refining, aluminum pot lines, gas production, steel mill processing, welding, power to d-c magnet coils, and battery charging.

High power germanium junction type of rectifier has an extremely low forward resistance (Fig. 2) and is ideal from an efficiency standpoint for applications requiring low to intermediate voltage outputs, at high current.

Because of its inherent characteristics, the germanium rectifier does not have a so-called nominal current rating. Its current rating is determined by the application, ambient temperature, degree and type of cooling, magnitude and frequency of short circuit current, steady state load current, and input voltage.

The germanium wafer is approximately 0.020 in. thick and the ability of the cell to handle large currents and dissipate large amounts of power depends largely on the packaging and cooling of the assembly. A maximum permissible junction temperature is established which would assure long life and extreme reliability. Temperatures in excess of this maximum would aggravate the presence of any contaminants, if they were present, and eventual deterioration of the cell would occur. Enclosure of the germanium sandwich in a hermetically-sealed housing has assured protection against entrance of any external contamination.

Maximum permissible junction temperature for the heavy power germanium rectifier, Type 6RA14 (Fig. 1) is 75C. This 75C value should be equal to or greater than the total sum of the ambient temperature plus the steady state temperature rise plus the transient or overload rise.

Steady State Losses

Under steady state conditions, the temperature at the junction of the cell is due to these contributing factors: ambient temperature and forward and reverse power losses. If it were ideal, the rectifier would not have forward resistance and infinite reverse resistance. Consequently, no power would be dissipated in the cell, and the theoretical maximum conversion efficiency would be obtained. Actual characteristics, however, depart from the ideal and power is dissipated by the cell during both the forward conduction and reverse blocking portions of the cycle.

As for forward losses: the forward current causes a forward voltage drop at the lower current densities by virtue of there being a P-N junction or barrier layer. At the higher current densities the forward voltage drop is a result of the presence of solders, bulk material and the unmodulated semi-conductor. At low current densities the voltage-current characteristics are non-linear (voltage drop varies logarithmically with the current) and a function of the junction resistance, while at the higher current densities the fixed resistance predominates and the voltage drop becomes proportional to the first power of current. The forward power dissipation curves are given in Fig. 3.

As for reverse losses: if the P-N junction were perfect, only saturation current would flow with the application of a reverse voltage. Homogeneity, however, is more difficult to obtain, the larger the contact surface. For example, better homogeneity is obtained with the point contact type than with the junction contact. The

*Application Engineer, Rectifier Dept, General Electric Co, Lynchburg, Va.

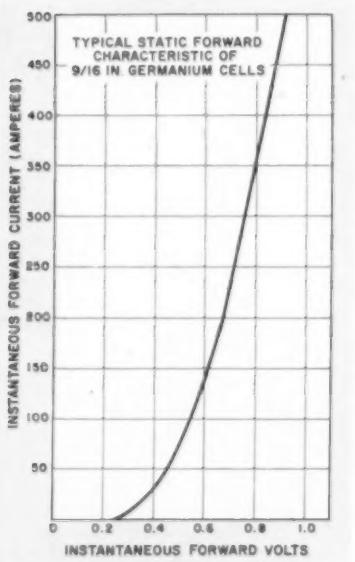


Fig. 2. High power junction type of rectifier has very low forward resistance

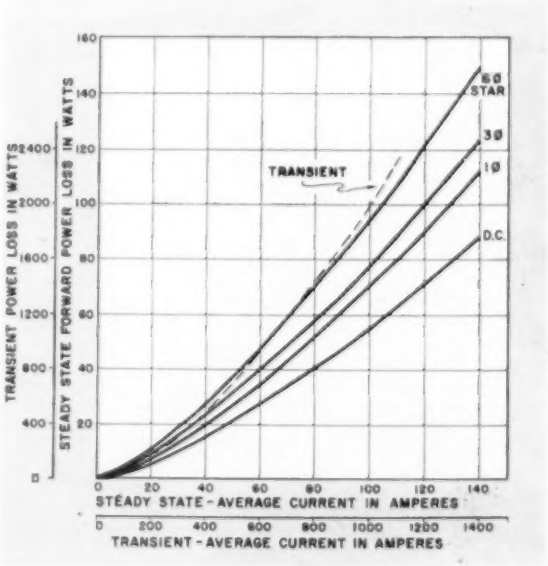
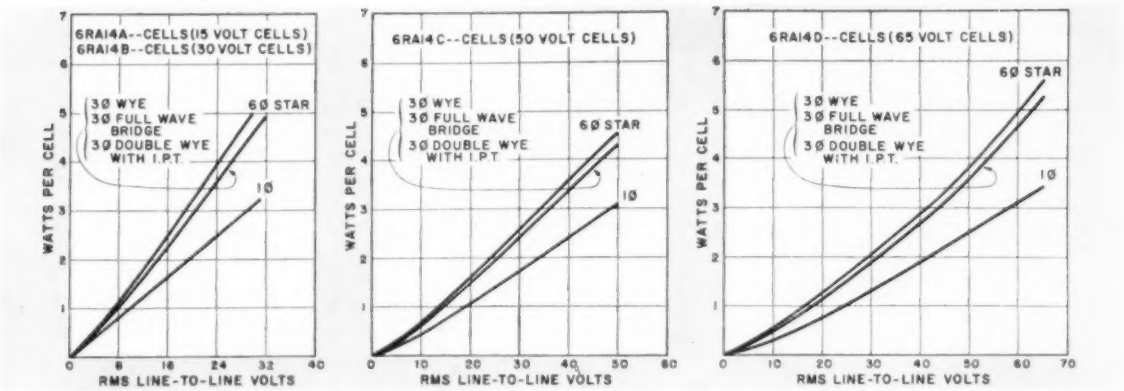


Fig. 3. Forward power dissipation curves for 6RA14 germanium rectifier, plotted as function of average current per cell



Figs. 4, 5, and 6. These graphs show the inverse losses as a function of rms inverse volts for 15 and 30, 50, 65v cells

reverse losses in the junction type of rectifier are primarily due to surface effects and improper wetting which form shunt paths for current flow. Figures 4, 5, and 6 show the inverse losses as a function of rms inverse volts for the 15 and 30, 50, 65 v rms rated rectifiers, respectively.

It may be concluded from the above that the presence of the forward and reverse losses and their contribution to junction heating must be considered in the application of these semi-conductors. The steady state thermal resistance of the rectifier package in deg C/watt as a function of cooling air velocity is given in Fig. 7. Watts referred to in this figure are the total steady state watts which are equal to the sum of the steady state forward and reverse losses.

Transient State

Under overload or fault conditions the rectifier is subjected to large currents which could destroy the cell if precautionary measures are not taken. These overloads contribute additional watts which must be dissipated by the cell and its heat sink assembly. For short time intervals (generally less than 50 milli-seconds) the capability of the rectifier to handle the large currents is primarily a function of its effective area.

Therefore the rectifier must be applied in a manner which allows it to handle these overloads or faults without failure. Figure 8 gives information as to the additional degrees centigrade rise or watts that may be handled as a function of time (over and above the steady state watts).

The curves given in this article must be used on a somewhat trial-and-error basis to obtain the optimum number of rectifier components. This was done intentionally, so that the curves would be applicable to all types of applications. If only one curve in the form of peak current versus time were included it would actually satisfy only one condition since a single steady operating condition would, of necessity, have been assumed.

Series and Parallel Operation

Germanium rectifiers may be connected for both series and parallel operation. To maintain a balance in voltage across the series rectifier string, it is recommended that each rectifier be shunted with a resistor. The value of resistance chosen should be such that it compensates for variations that exist in the reverse characteristics of the cells that are assembled in the series string. The lower the value of resistance, the better the distribution of voltage.

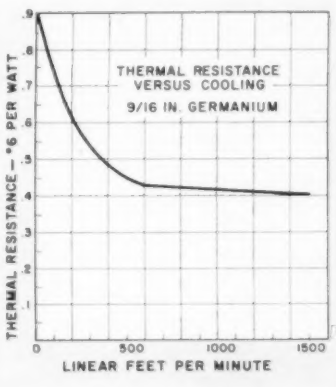


Fig. 7. This shows steady state thermal resistance of rectifier package

Of course, there are efficiency and loss factors to be considered in the design of equipment. As a general rule it may be said that the value of resistance to be used should not exceed an amount which would bleed off a value of current approximately

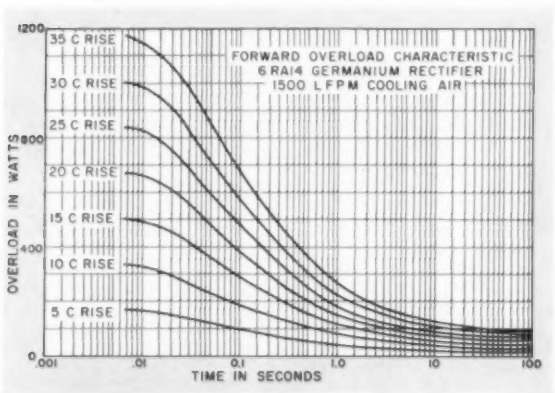


Fig. 8. Additional degrees C rise or watts that may be handled as a function of time over and above steady state watts

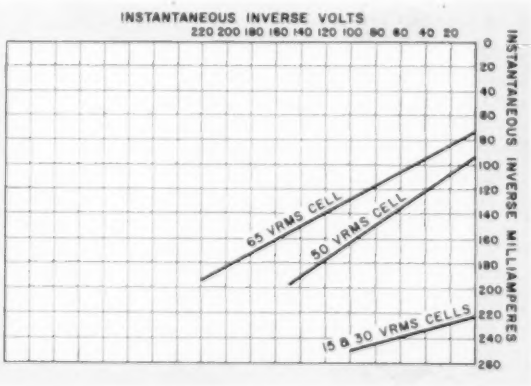


Fig. 9. Instantaneous reverse characteristics of 9/16-in. cells. Leakage from 65-v cell at 80 inverse v equals 118 ma

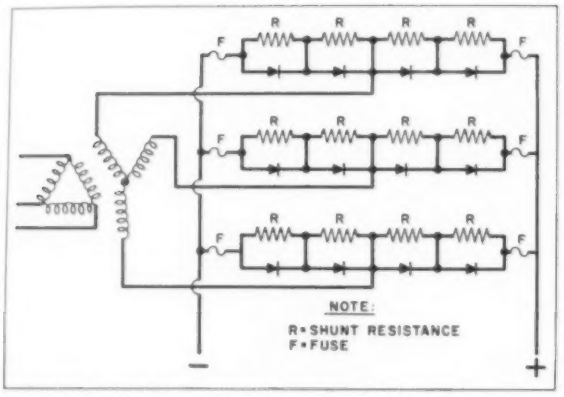


Fig. 10. Series connection of two germanium rectifier cells per arm of three-phase bridge circuit. This is typical plan

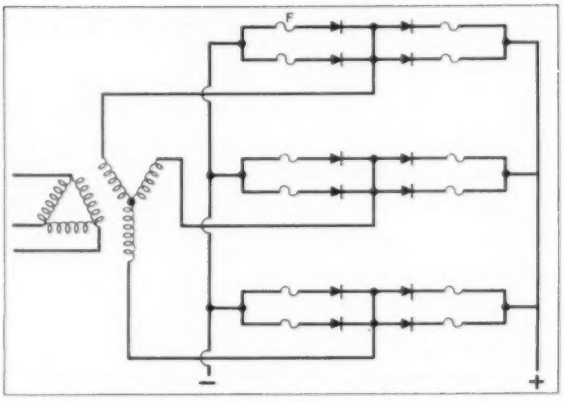


Fig. 11. For optimum load sharing, parallel connection of two germanium rectifier cells per arm of three-phase bridge

equal to two times the reverse leakage of the cell at the operating inverse voltage. For example, if it is assumed that the cell is operating at 80 peak inverse volts, the leakage current from Fig. 9 (65-v rms cell) is seen to be 118 ma. The value of shunt resistance to use, therefore, is

$$R \leq \frac{80 \text{ volts}}{(2)\,(0.118)\text{amps}} \leq 340 \text{ ohms.}$$

A typical connection diagram is shown in Fig. 10.

For purposes of paralleling, the Rectifier Department of General Electric has established a testing procedure whereby each germanium rectifier stack is forward grade coded. Stacks having the same code number may be assembled in parallel, for optimum load sharing (Fig. 11).

Because of the small mass and consequently low thermal capacity of the germanium cell, it is imperative that it not be exposed to excessive currents for any extended period of time. It becomes necessary, therefore, to limit or interrupt currents that are capable of destroying the cell.

Current limiting fuses and breakers are being used in most present-day equipment for protection purposes. Proper coördination, however, must be obtained between the characteristics of the current limiting fuse, the tripping time of the breaker, the available fault current, and the overload characteristic of the rectifier stack.

The current limiting fuses are generally assembled one for each parallel path of a circuit element for purposes of protecting the good cells in the event that a cell develops an internal short. The good cells would feed into and hence blow the fuse that is in series with the faulty cells. The breaker, of course, which has a characteristic which lies below that of either the cell or fuse should interrupt current within a specified time when an external fault develops.

It has been found through test that voltage transients may exist when a circuit is first energized, and also when current flow is interrupted. These voltage transient peaks must be kept within reasonable limits.

For protection against high-frequency voltage transients, it is recommended that capacitors of approximately 10 to 20 microfarads be connected from each transformer secondary phase to ground.

Also, because of the recovery phenomena associated with germanium rectifiers, it has been found that a germanium rectifier can fail during recovery if high voltages are imposed as a result of a sufficiently fast rise time in reverse voltage. The recommendation is that capacitors (approximately 20 microfarads) be connected across each rectifying arm or circuit element. Lead inductance should be minimum. THE END

EXAMPLE

250 kw 50 d-c v anodizing application utilizing a three-phase, full-wave bridge circuit. Calculated fault current in order of 25,000 d-c amp. Ambient temperature 40C and cooling air is supplied at 1500 linear fpm. Current limiting fuses and circuit breaker (interrupts within 3 cycles) are being used for protection.

(a) How many rectifiers in parallel are required?

(b) What is the total number of rectifiers required for the application?

Answer to A

(1) From previous calculations, it was determined that the minimum number of cells that would satisfy both the steady state and fault conditions (optimum operation for a ratio of $\frac{\text{fault current}}{\text{steady state load current}} = 5$) was such that 13.5C rise should be allowed for the overload condition. Hence, the allowable steady state rise is 75C − 40C − 13.5C = 21.5C = T_m.

(2) From Fig. 7 the thermal resistance of the package (R_t) at 1500 fpm is seen to be equal to 0.4 C/watt.

(3) Steady state total watts = $\frac{T_m}{R_t} = \frac{21.5}{0.4} = 54$ watts

(4) Using Fig. 5 (50-v rms cell) and estimating the rms inverse voltage to be approximately 37 v (50 ÷ 1.35), the inverse loss is seen to be 3.5 watts.

(5) Forward watts loss (steady state) = Total steady state losses − inverse losses = 54 − 3.5 = 50.5 watts.

(6) From Fig. 3, the steady state average current rating per cell for the 3 Ø F.W.B. circuit with 50.5 watts forward dissipation is 73 amp average per cell.

(7) Number of rectifier cells required in parallel = $\frac{5000}{3 \times 73} = 23$

(8) As a cross-check the total watts being dissipated under overload conditions equals the steady state watts plus the additional watts contribution due to the overload. From Fig. 8 the overload watts for a 13.5C rise and 3-cycle time interval is 370 watts. Hence total watts (during overload) = 54 (step 3) + 370 = 424 watts.

From Fig. 3, the average current per cell (using transient characteristic due to 180 deg conduction period per cell as a result of a d-c fault) with 424 watts dissipation per cell is found to be 360 amp average per cell.

Hence, number parallel cells required = $\frac{25{,}000}{3 \times 360} = 23$ (checks).

Note: This is the method which was used to determine 13.5C rise starting point in step 1. Maximum of three trials is required to arrive at curve to determine optimum conditions.

Answer to B

Since a three-phase bridge circuit is being used, the basic cell combination is 6 — X — Y; the 6 specifying six circuit elements; the X, number of series cells; and Y, number of parallel elements.

Hence, the circuit combination becomes, 6-1-23, and cross multiplying, the total number of rectifier cells becomes 6 × 1 × 23 = 138.

Quick Cleaning With Ultrasonics Saves Meters

ULTRASONIC CLEANING has made it possible to salvage many types of meters and similar devices, even those which formerly had to be scrapped. The "Sonogen" ultrasonic generator used for this method is a model AP-25-B, together with a type T-52 tank-transducer combination. Dimensions of the tank are 7½ by 9 by 13 in. high, which gives the tank an effective cleaning area of 52 sq in.

The generator converts 115-v 60-cycle a-c into high-frequency (38 kc) electrical energy and, by means of the transducer, transmits mechanical vibrations of the same frequency into the cleaning fluid. Cavitation, which is a continual rapid build-up and collapse of pressure, is set up, causing very intense scrubbing action. It literally blasts the oil, grease, sludge, carbon, soot and other contaminants from any part suspended in the cleaning fluid. The process is quick, with a minimum of hand labor.

Because these high-energy pressure waves are transmitted in all directions, even those areas which are normally inaccessible by other methods can be cleaned, such as blind holes, crevices, undercuts, threaded sections. Anti-friction bearings, especially, are cleaned very effectively and quickly, without disassembly.

The cleaning fluid frequently used in cleaning meter components ultrasonically is trichlorethylene, at temperatures of 110 to 140 F. However, water solutions of alkaline detergents may be preferred for certain types of deposits, especially where redistillation and recovery of solvents is not feasible.

Tank transducer units holding up to 25 gallons of cleaning liquid are available, driven by larger Sonogen ultrasonic generators. For additional information, write The Editor, POWER ENGINEERING, or jot Sonogen on the return postcard inserted elsewhere in this issue.

Components to be cleaned are hung on a wire, immersed in the fluid with the ultrasonic power turned on, and agitated for about one-half to three min

It's Easy to Use This New Epoxy Resin Cement

A NEW aluminum-filled epoxy resin is being marketed in self-metering tubes to give additional convenience and economy in its many applications. This resin-catalyst system comes packed in two collapsible tubes. The proper proportions of resin and catalyst are accurately measured automatically by squeezing out identical lengths of each material from its respective tube, onto a glass or wood surface. The two different colored components are then mixed to a uniform color. Additional amounts can be mixed if needed, or the tubes stored for later use.

This material can be used as a patching medium for wood, metal, plastics and concrete. It is highly recommended as a smoothing and caulking compound, and as a repair cement for tanks, pipes, conduits, and windows. Compounded from the same materials now being used for cementing airplane parts together, it can be used as an adhesive material for bonding metals, wood, concrete and glass. Being water and oil-resistant, this product lends itself to many repair jobs around power equipment; it also resists acids and alkalis, and is non-flammable.

Compound can be applied to vertical surfaces without sagging, and is said to retain this quality after extended storage. After catalyst has been added to the base material, the product hardens at room temperature; or for quick repairs it can be set in a short time by the addition of heat. Finished repairs can be machined by conventional means to a feather edge, and will withstand considerable mechanical shock — due to the flexibility of the compound.

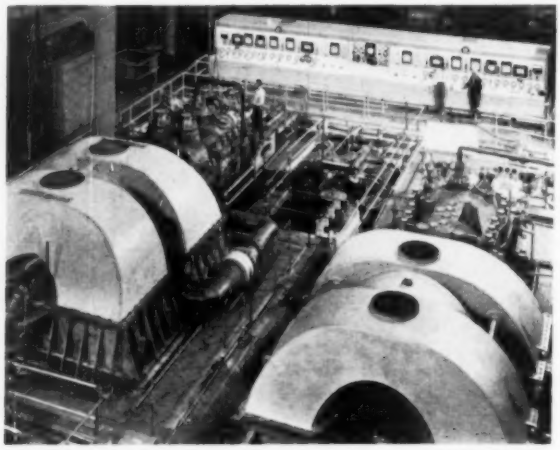
The family of epoxy resins was first announced only a short time ago, yet their amazing adhesive values have led to many new applications in the industrial field. The combination of aluminum powder and the epoxy resin has resulted in a compound which opens up a field of repairs thought impractical heretofore.

For additional information on this product and its uses write the Editor, or jot Epoxy Resin Cement on the prepaid return post card elsewhere in this issue.

Compound being used to make repair in cast iron pipe. Patch can later be sanded or filed smooth if original contour is desired. Note separate tubes of compound

POWER ENGINEERING'S

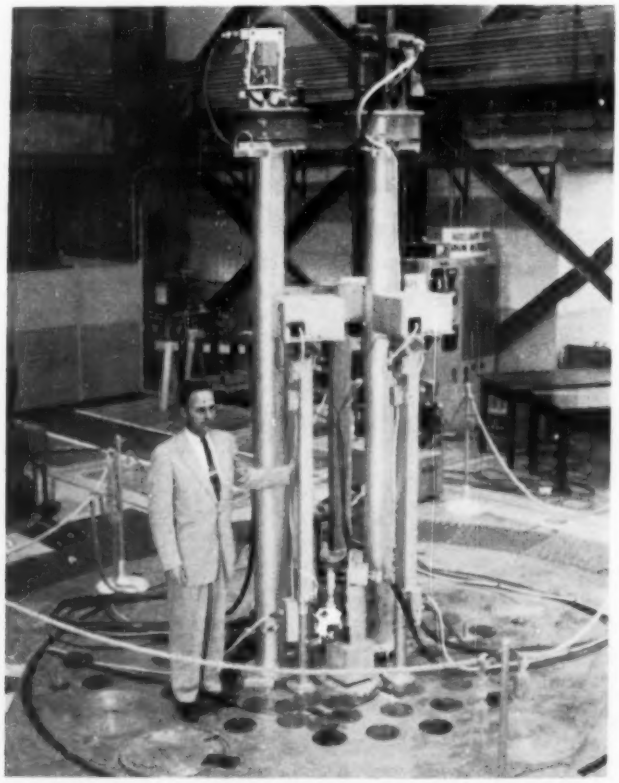
Future power engineers, students in mechanical engineering at University of North Dakota, get demonstration of new Babcock & Wilcox boiler from model. Lecturer is W. R. Little of B&W. Demonstration is part of company's college program. Edward Lawson heads Dakota engineering school



Testing big ones at Allis-Chalmers' steam turbine assembly pit. These are 150-mw and 100-mw double-flow, tandem-compound steam turbines with side-crossunders. Shop pipe on left unit shows location of side-crossunder. Side-crossunders need not be removed for turbine inspection

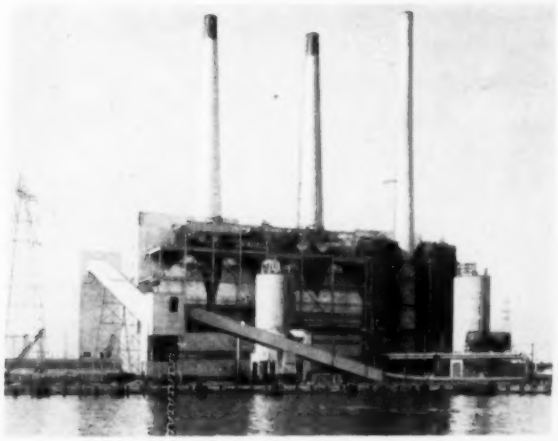
Torture test for enclosed electric motors is given by sou'wester-clad GE technician ably aided by fire hose. Water at 8 psi strikes all areas

World's most intense source of irradiated cobalt for its size (1.18 in. long, 0.3-in. diam, 2640 curies) is monitored by Phillips Petroleum Co for safe handling under water. Capsule goes to the Argonne Cancer Research Hospital

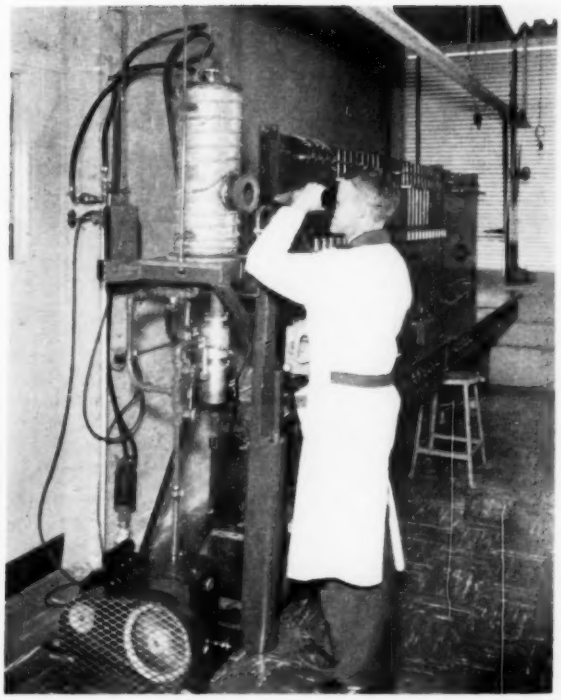


K. K. Kennedy, reactor maintenance supervisor, Atomics International, at control rods of Sodium Reactor Experiment. Heat produced experimentally by this reactor in the Santa Susanna mountains near Los Angeles is converted into electricity by Southern California Edison and fed into their system. Company pays 45 cents per million Btu. Reactor uses sodium as liquid metal coolant

NEWS REEL



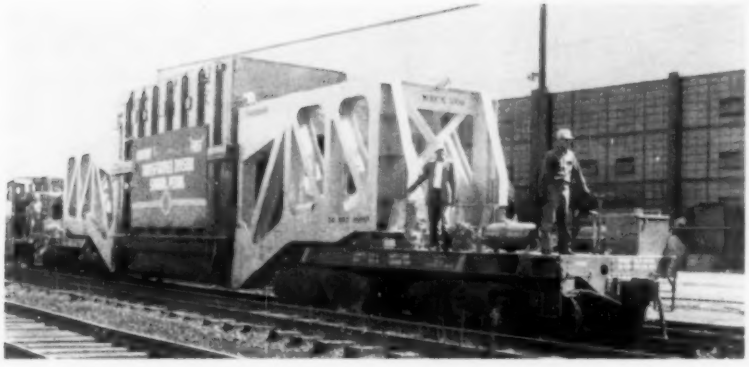
On River Rouge, Detroit Edison's newest generating station houses some of the world's most powerful equipment for producing electricity. Station's second steam turbine generator (out of three) recently went into operation, adding 260,000 kw, upping system's total capacity to over 3,000,000 kw

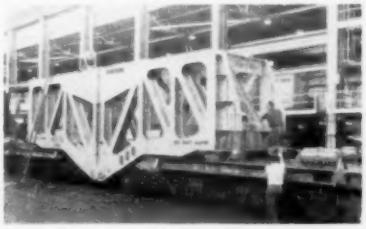


Life in a vacuum—for resistance wire, that is—being checked with an optical pyrometer at Hoskins Mfg Co. This special vacuum-atmosphere equipment tests multiple resistance wire specimens in vacuum as low as 0.5 microns, throughout resistance heating test range of 1600 to 2600 F. Equipment also furnishes helpful data on alloys for h-t use

◀ **Life in a tower** for nation's engineers is expected to become a reality late in 1960 when this striking building for a new United Engineering Center will be opened for occupancy on United Nations Plaza between 47th and 48th Streets in New York City. The $10,000,000 Center will replace present Engineering Societies Building on 39th St

First 3-part railroad car, designed by Westinghouse for transporting huge power transformers, has two identical sections each 30 ft long with steel framework, underframe and wheel trucks. Framework is anchored to two "halves," holds transformer suspended in center, only 6 in. above the rails. Car closes up (right photo) for return trip





Evaporator or Demineralizer—Which is Best?

Lively argument still continues over the comparative advantages of these two methods of providing feedwater for modern steam generators. This article—and one to follow—present pertinent facts

By EVERETT P. PARTRIDGE and S. R. OSBORNE*

DURING the quarter of a century from 1925 to 1950, the unit of measure for substances dissolved in boiler feedwater shifted slowly from grains per gallon to parts per million. Seven years ago, a level of 1.5 ppm of dissolved solids was used for a comparison of the relative merits of evaporation and demineralization.[1] Now, however, we are rushing headlong into the era of ultra-purity, with parts per billion as the new criterion. An item appearing recently states that the feedwater for Avon No. 8 of the Cleveland Electric Illuminating Co should contain no more than 50 ppb of total solids.[2]

Why Ultra-Pure Water?

Why is ultra-purity to this degree required? At the moment, such a specification presumably involves a "factor of ignorance" greater than normal, for Avon No. 8 will be a once-through supercritical-pressure boiler of the Sulzer type, designed to deliver to the turbine throttle 1,715,000 lb per hr of steam at 3500 psig and 1100 F, with reheat to 1050 F.

At a pressure above the critical value of about 3200 psi there can be no mechanical separation of liquid from vapor to remove the last bit of concentrated boiler water from steam prior to superheating. The feedwater entering such a supercritical unit must therefore either pass through the long circuit carrying everything initially present in it, or it must deposit some of its burden along the way. How much if anything can be carried in solution by water at 3500 psig and 1100 F is largely unknown today.

It is no wonder, therefore, that the purest water believed to be attainable has been specified for Avon No. 8. Make-up will be prepared by two-stage demineralization. In addition, condensate will be polished continuously by a mixed-bed unit through which part of the feedwater will be bypassed.

Feedwater containing 100 ppb of dissolved solids is expected to suffice for the once-through supercritical-pressure unit at Eddystone Station of Philadelphia Electric Company.[3] This is planned to produce 1,540,000 lb per hr of steam at 5000 psig and 1200 F at the turbine throttle, although initial operation will be limited to 1150 F. There will be two stages of reheat to 1050 F, with pressures approximating 1050 and 250 psig. Demineralization will be used to provide make-up with a solids content of less than 100 ppb. If leakage of cooling water occurs through the condenser, a bypass demineralizer capable of handling a substantial portion of the condensate will be employed to remove solids thus introduced.

Even somewhat less purity appeared to be satisfactory during a 4000-hour run of a pilot plant for the supercritical-pressure boiler now in service at Philo Station of American Gas and Electric Service Corporation. This boiler has been designed to produce 675,000 lb per hr of steam at 4500 psi and 1150 F with double reheat, first at 1225 psi to 1050 F and then at 185 psi to 1000 F.[4,5] The boiler water is to contain no more than 500 ppb of solids.

Russian scientists, working with a pilot unit of about 26,500 lb per hr capacity at 300 ata (4266 psia) and 600 C (1112 F), report 80 to 90 per cent carry-through of the 200–500 ppb solid impurities in the feedwater.[6] Further experimentation in the 300–700 ppb range of salt impurity revealed that any calcium or magnesium is essentially all deposited in the boiler, but trace concentrations of sodium salts are almost completely carried away in the "steam." They conclude that, in the supercritical range, condenser leakage and make-up purity must be such as not to result in more than 50 ppb solids at the turbine throttle. One system suggested for removal of solids from the cycle is continuous blowdown from the wet stages of the turbine.[7]

A limit of 500 ppb of total solids has sufficed in the case of Sulzer once-through boilers operated in Europe at pressures well below the critical

*Both of the Hall Laboratories, Inc., Pittsburgh, Penna.

Table I. These comparative data were determined in the laboratory for station make-up prepared by both methods

Purity of make-up produced by evaporation and by mixed-bed demineralization in Central Station A

	Concentration, ppm	
	Evaporator Vapor	Demineralizer Effluent
Total solids at 105 C	0.78	0.57
Volatile solids at 450 C	0.31	0.47
Fixed solids at 450 C	0.47	0.10
*Sodium (Na)	0.145	0.014
Hardness ($CaCO_3$)	0.113	0.024
Calcium (Ca)	0.030	.....
Magnesium (Mg)	0.009	.....
Iron (Fe)	0.009	0.012
Silica (SiO_2)	0.005	0.032
Sulfate (SO_4)	0.254	.....
Conductivity, mmho/cm	4.5-6.8	<0.1

* Potassium was found to be present only to a negligible extent.

Table II. Similar spot check of make-up in a central station on Niagara River. Evaporator uses a bubble-tray purifier

Purity of make-up produced by evaporation and by mixed-bed demineralization in Central Station B

	Concentration, ppm	
	Evaporator Vapor	Demineralizer Effluent
Total solids at 105 C	1.03	0.32
Volatile solids at 450 C	0.27	0.22
Fixed solids at 450 C	0.76	0.10
Sodium (Na)	0.05	0.027
Potassium (K)	0.01	0.005
Hardness ($CaCO_3$)	0.04	0.018
Iron (Fe)	0.08	0.008
Copper (Cu)	0.30	.....
Silica (SiO_2)	0.04	0.013
Sulfate (SO_4)	0.17	.....

Table III (below) gives data on make-up for a new once-through boiler. Table IV (top, right) compares Table III carry over at half and full load, measured by sodium tracers. Table V shows vapor scrubbers' effect on evaporator

Carry over from evaporators in Central Station C

	Concentrations, parts per million			
Evaporator	2	1	2	1
Date	6/10/56	7/2/56	7/18/56	7/18/56
Total solids at 105 C	0.19	0.21	0.23	0.43
Volatile solids at 450 C	0.08	0.13	0.15	0.19
Fixed solids at 450 C	0.11	0.08	0.08	0.24
Sodium (Na)	....	0.017	0.015	0.056
Potassium (K)	....	0.002	0.001	0.003
Silica (SiO_2)	....	0.009	0.006	0.009
Iron (Fe)	....	0.004	0.007	0.010
Hardness ($CaCO_3$)	....	0.044	0.020	0.039

Effect of evaporator rating on purity of vapor in Central Station C

	Sodium (Na), ppm	
	in brine	in vapor
Half load (normal)	662	0.068
Full load	1090	0.303

Effectiveness of three systems for scrubbing vapor from a submerged-coil evaporator (12)

Scrubbing System	Average Over-all Decontamination Factor
8.8-ft bed of 0.5-in. Raschig rings	9×10^5
13-plate column with 2-in. bubble caps	6×10^6
4.5-ft packing of 20-μ Fiberglas	4×10^7

value. In these units, however, mechanical separators are used to remove the last 3 or 4 per cent of residual concentrated boiler water from the steam before it enters the superheating section. The first unit of this type in the United States, constructed for Dayton Power and Light Company, will produce 940,000 lb per hr of steam at 2400 psig and 1050 F, with reheat to 1000 F. It is to be supplied with feedwater containing not more than 500 ppb of dissolved solids.

At first glance, the requirements for recirculating boilers with steam drums seem of a much lower order of purity.[8] But the demand for ultra-pure feedwater is still present, even though not explicitly stated. If silica in the boiler water is to be kept at 1–2 ppm and blowdown is not to exceed 0.5 per cent, then silica in the make-up must be only 0.005–0.01 ppm more than equivalent to the magnesium ion. So again we find ourselves in the range of parts per billion, if only with respect to one constituent.

Whether we talk about natural or controlled circulation in high-pressure boilers with steam drums or about once-through boilers at subcritical or supercritical pressures, we cannot escape the necessity for supplying make-up ultra-pure in at least some respect. Should we produce it by evaporation or demineralization?

Capability of Processes

There is a natural tendency to get sidetracked on a discussion of whether evaporation or demineralization will produce the purer water, as if "pure" water were an end in itself. But water need be only of sufficient quality so that the cost of whatever trouble it causes, added to the cost of attaining and maintaining that quality, produces a minimum. Only because engineers are not yet sure what degree of purity will produce this minimum, do they ask for the greatest purity.

Measurement of purity has itself been uncertain. Evaporation of a large sample of water and weighing of the residue is time-consuming and may yield high values unless extreme precautions are taken to exclude dust.

Estimation of dissolved solids from electrical conductivity requires elimination of volatile constituents such as carbon dioxide, ammonia and amines, or accurate correction of the measured conductivity for the effect of these substances. Even if this could be done precisely, we would still have the uncertainty of dealing with numbers for the conductivity due to dissolved solids of the same small order of magnitude as the conductivity calculated for pure water, 0.05 mmho per cm. Moreover, silica may be present in a form which does not contribute to the electrical conductivity.

Currently there is great interest in the sodium tracer method [9] for estimating the carry over of dissolved salts from a boiler or evaporator. It is hoped that this may provide a basis for more accurate determination of performance.

During the past decade the extremely low figures for dissolved solids and silica attainable by demineralization have been reiterated so many times that this process is now almost synonymous with ultra-purity. In contrast, the manufacturers of evaporators have generally been content to guarantee no better purity than 1 ppm of dissolved solids, extending themselves only occasionally to promise 0.5 ppm [11] or lower.

A survey by the Prime Movers Committee of the Pennsylvania Electric Association in 1949, covering 22 evaporators installed after 1938, showed that only seven of these were capable of producing at full rated capacity a vapor containing no more than 1 ppm of dissolved solids. Buchanan and Pace,[10] describing the experiences of the Duquesne Light Company, emphasized four points which would allow this level of purity:

1. Purchase of an evaporator of adequate size (capacity four times calculated make-up); 2. design station so that operation of evaporator is not affected by turbine load changes; 3. provide feedwater to the evaporator of such quality that operation will be continuous without corrosion and scale troubles (periods between inspection and cleaning have been as long as 5 to 10 years); 4. determine optimum load, water level and liquor concentration and operate under these conditions.

It is not difficult to find cases where demineralization is producing water of higher purity than is evaporation. The comparative data in Table I were determined by our laboratory for a central station where make-up is prepared by both systems. Water from the Ohio River is clarified and filtered. This goes directly to the mixed-bed demineralizing plant but is zeolite-softened before feeding to the evaporator. The solids were determined by evaporation of 27 liters of sample in a special laboratory evaporator equipped with an efficient filter for the entering air.

Studying the data, we see that the demineralizer, the resin in which had recently been replaced, was performing excellently. The conductivity of the effluent reported by the plant was less than 0.1 mmho per cm. Our determination of fixed solids at 450 C gave only 0.1 ppm. However, 0.032 ppm of this was silica. The evaporator was easily meeting its guarantee of 1 ppm of dissolved solids, although this was not apparent from the uncorrected reading for conductivity.

The major constituent in the carry over was sodium sulfate, but only one-sixth as much silica was present as in the effluent from the demineralizer.

A similar spot check of make-up in a central station on the Niagara River yielded the data of Table II. Here the sample from the demineral-

izer contains only 0.1 ppm of fixed solids at 450 C, of which 0.013 is silica. The evaporator, which is equipped with a bubble-tray purifier, shows less total carry over of the normal constituents of the brine than in the preceding case represented by Table I, although silica is higher. The condensed vapor is obviously corrosive, as indicated by the high values for iron and particularly for copper, which scarcely could be accounted for by carry over. Since these would be present as oxides after ignition of the platinum evaporating dish, they would represent about 0.48 ppm of the 0.76 ppm of fixed solids at 450 C. Actual carry over of fixed solids would thus appear to be less than 0.3 ppm, but control of corrosion by the condensed vapor is needed.

In another plant test not conducted by us, a bubble-tray evaporator operated at up to 110 per cent of design rating is reported to have produced vapor containing not more than 0.2 ppm of dissolved solids from brine averaging 2800 ppm of solids.

The data in Table III were determined recently by us for a plant investigating evaporation of make-up for a new once-through boiler. Solids were determined in the laboratory evaporator. The fixed solids at 450 C ran about 0.1 ppm in three of the samples and 0.24 in the fourth.

This evaporator is a bent-tube unit installed in 1954. Rated to produce 20,000 lb per hr of steam containing not more than 1 ppm of dissolved solids from brine containing 3000 ppm, it has a disengaging surface of approximately 125 ft^2 and a centrifugal moisture separator. The data in Table 3 were obtained at approximately half load, corresponding to normal operation. A comparison of carry over at half load and at full load is given in Table IV. These measurements by the sodium tracer method indicated 4.5 times as much carry over at the higher rating and higher concentration of brine. The "decontamination factor" from brine to vapor was 1 x 10^4 at half load but decreased at full load to 3.6 x 10^3.

Still better performance than this is possible if the manufacturers of evaporators wish to develop their equipment to meet the new demands for ultra-purity and if the prospective customer concludes that such improved equipment is attractive in spite of a presumably higher initial cost.

For example, as shown in Table V, decontamination factors ranging from 9 x 10^5 to 4 x 10^7 were obtained by the use of vapor scrubbers packed with various materials in tests with an evaporator concentrating radioactive wastes.[12]

This investigation incidentally revealed an interesting variation in purity of vapor as the rate of evaporation was increased without scrubbing devices in the system. Up to a rate of from about 20 to 30 lb of vapor leaving a square foot of disengaging surface per hour, the purity progressively improved. Then, with further increase in rate, purity fell off sharply.

It is interesting to compare this range for the transition point with the statement by Buchanan and Pace [10] that an evaporator with a nominal rating of 10,000 lb per hr and a disengaging area of 90 ft^2 should actually be operated at 25 per cent of nominal capacity. Such operation would produce about 28 lb per hr-ft^2 of vapor. The excellent results of Table II with a much higher vapor release of approximately 70 lb per hr-ft^2 presumably attest to the effectiveness of the centrifugal moisture separator.

As we consider the possibilities of vapor scrubbing on one hand and of conservative sizing on the other against the background of known performance of individual evaporators, we think evaporation is fully capable of producing make-up sufficiently free of dissolved solids to be fed to once-through boilers operating at either subcritical or supercritical pressure. Engineering judgment of economic analyses will then determine whether evaporation or demineralization should be chosen. THE END

REFERENCES

1. Calise, V. J., High Pressure Boiler Feedwater Treatment, Evaporation vs. Demineralizing and Silica Removal, Proc. 11th Annual Water Conference, Engrs. Soc. Western Pa., pp. 41–59 (1950).
2. Dauber, C. A., Avon No. 8, A Supercritical Pressure Plant, *Combustion*, vol. 28, No. 2, pp. 47–56 (1956).
3. Hunter, A. T., The Monotube Once-Through Boiler for Conventional or Supercritical Pressures, Proc. Am. Power Conf., 17, 103–10 (1955).
4. Fiala, S. N., First Commercial Supercritical Pressure Steam-Electric Generating Unit for Philo Plant, Am. Soc. Mech. Eng. Preprint 55-A-137, Blast Furnace and Steel Plant, vol. 44, No. 3, 324–28 (1956).
5. Rowand, W. H. and Frendberg, A. M., First Commercial Supercritical Pressure Steam Generator for Philo Plant, Am. Soc. Mech. Eng. Preprint 55-A-135.
6. Rakov, K. A., Krol, L. B., Panasenko, M. D., and Bulgakova, N. V., Experimental Boiler Plant with Once-Through Boiler for Steam Conditions up to 4266 Psia, 1112 F, *Combustion*, vol. 28, No. 3, pp. 42–7 (1956).
7. Styrikovich, M. A., Working Process of Super-High-Pressure Once-Through Boilers, *Combustion*, vol. 28, No. 3, pp. 49–53 (1956).
8. Manual of Industry Standards and Engineering Information, Am. Boiler and Affiliated Industries, p. 2–1.1 (Sept. 1956).
9. Coulter, E. E. and Campbell, T. M., Steam Purity Determination by Tracer Techniques, Am. Soc. for Testing Materials Preprint 93b (1956).
10. Buchanan, R. M. and Pace, A. A., Vapor Purity to be Expected, Proc. 11th Annual Water Conf. Eng. Soc. Western Pa., pp. 61–9 (1950).
11. Whirl, S. F. (discussion of reference 10), Proc. 13th Annual Water Conference, Eng. Soc. Western Pa., pp. 53–4 (1952).
12. Manowitz, B., Bretton, R. H., and Horrigan, R. V., Entrainment in Evaporators, *Chem. Eng. Progress*, vol. 51, pp. 313–9 (1955).

New Material Will Improve Transformer Efficiency

"FOUR-SQUARE" silicon iron, a new kind of sheet material designed to increase the efficiency of transformers, motors and generators, has been developed at the General Electric Research Laboratory.

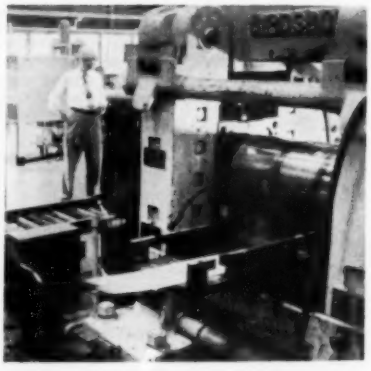
The new doubly-oriented magnetic sheet material, which is easily magnetized in four directions and can be made in a wide range of useful thicknesses, has been produced by theoretical metallurgists working side-by-side with processing experts.

Lower energy losses and reduced noise in many types of electrical equipment can be expected when four-square silicon iron gets into actual production, according to GE researchers.

Doubly-oriented magnetic sheet has been a research goal for more than 20 years, ever since metallurgists learned how to make singly-oriented sheet materials that can be easily magnetized in two directions (back and forth lengthwise along the sheet). "Orientation" in silicon iron is achieved by aligning the individual crystalline grains in the finished sheet material. The doubly-oriented four-square effect is produced by a different kind of alignment (technically referred to as "cube texture") which gives excellent magnetic properties not only back and forth along the sheet but also back and forth across the sheet.

By properly lining up the sheet in a transformer, generator or motor, most — but not all — of the magnetic flux can be carried in these "easy" directions.

The new magnetic sheet is currently in pilot-plant production at the General Electric Research Laboratory.



Four-square iron is made in much the same way as single-oriented materials. Rolling and heat-treating of cast ingots produces long sheets about 12 in wide

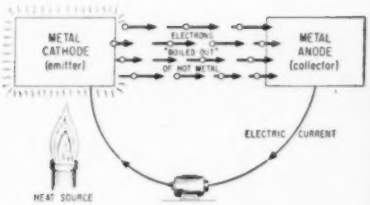


Fig. 1. Principle of thermionic converter. New approaches to design of cathode, anode, materials used, and gas environment have smoothed path of the electrons to make an electric circuit

Fig. 2. Volney Wilson, inventor of converter, holds bulb lit with electricity generated directly from heat

Getting Electricity from Heat—Direct

DIRECT CONVERSION of heat energy into electrical energy has been achieved in a unique electronic device developed at General Electric Research Laboratory.

Invented by Dr. Volney C. Wilson, a new thermionic converter takes advantage of the simple fact that electrons can be "boiled out" of a hot metal surface and used to produce an electric current directly (Fig. 1). Experimental converters already have changed more than eight per cent of the applied heat energy into electric power.

The hope is that thermionic converters ultimately may be able to change more than 30 per cent of heat energy directly into electricity (compared with the 40 per cent rate of most efficient steam turbine generators). However, as of now the thermionic converter is an experimental lab device only and its commercial application is a question for the future.

Boiling Out Electrons

Thermionic converters combine several known scientific principles in a novel manner. Two electrodes within the tube-like device are maintained at high, but different, temperatures. New approaches to the design of the electrodes, the materials used, and the gas environment within the envelope have resulted in a more efficient flow of electrons than ever noted before.

In explaining his invention, Dr. Wilson said that when heat boils electrons out of the metal surface, it is analogous to lifting water to the top of a hill. "If we let the water flow down the hill, it can do work — run a water wheel, for instance — but only if we can provide the water with a smooth, uninterrupted path down the hill.

"The thermionic converter essentially smooths the path of electrons from a hot electrode (above 2500 F) to a cooler one, and removes barriers which in the past have absorbed the energy before it could do useful work in an electric circuit."

Other Ways

Most previous methods of converting heat directly into electricity — without rotating machinery — have been based on the thermocouple, a device long used for measurement and control functions. Thermocouples using a junction of two different kinds of metal produce small electric currents when heated, but their efficiencies normally are well below one per cent.

One obvious difference between the thermionic converter and the thermocouple is that in the former the metals are separated by a gas at very low pressure. There is an electric flow between the electrodes, but there is less flow of heat than through a metal. Thus the electrodes can be at different temperatures, and the efficiency is greatly increased.

The trouble any electron has in passing from one electrode to another is called the "space-charge" effect. The electron tends to be repelled by the trillions of other similarly charged electrons. In the thermionic envelope, positively charged ions are set up in the atmosphere between the electrodes. These ions act as policemen, allowing millions of negatively charged electrons to reach the anode, thus creating a flow of current.

General Electric is reported to be investigating several approaches to the problem of converting heat directly into electricity, including thermocouples using semiconductors.

Fig. 3. Thermionic converter looks like this, is now used as experimental device

For nearly every vacuum-electronic tube device or system there is a similar solid-state semiconductor method of accomplishing a similar electrical result, G-E researchers point out. The semiconductor device corresponding to the thermionic converter is a thermo-junction which, upon heating, will produce a flow of current and power in an external circuit. This same semiconductor junction may be used to produce heat when the current flows in one direction, or to produce cold when current flows in the opposite direction.

Centralizing Boilers Into Single Plant Pays Off at Convair

Rapid expansion during wartime necessitated the installation of twenty-two boilers—in 5 locations—at Convair's San Diego plant. A new central plant has replaced the scattered units, with a handsome saving in labor, plus a sizable increase in operating efficiency

By W. H. ODLE *

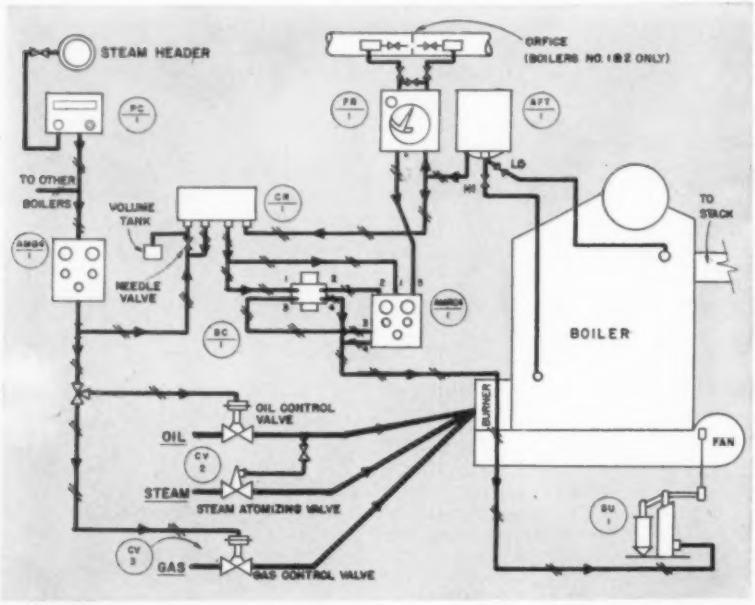


Fig. 1. Schematic diagram showing controls for regulating the flow of oil, gas and air supplies to boiler. Note control of air adjustment from master regulator

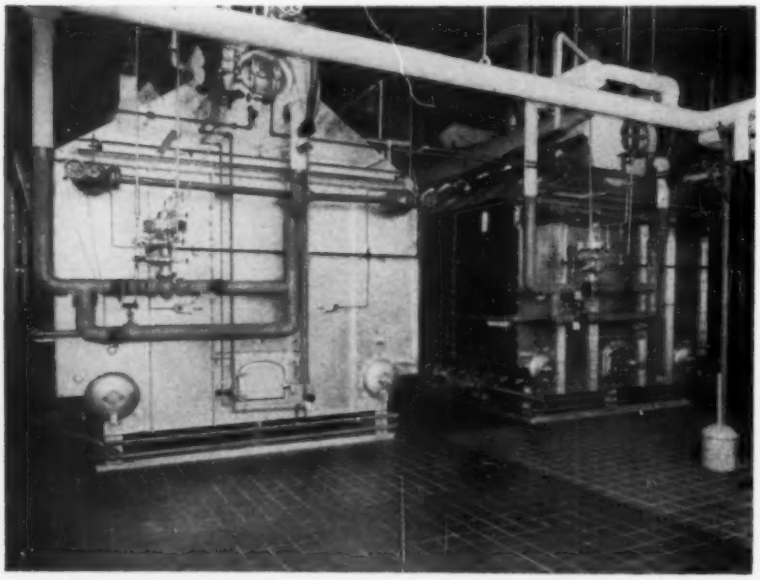


Fig. 2. Feedwater regulators are two-element, and operate from drum level and steam flow, and in turn control the feedwater regulating valve to boiler

CENTRALIZING its power facilities in a new boiler house has enabled Convair, a Division of General Dynamics Corp, to retire twenty-two old boilers in four widely separated locations; also to reduce operating personnel, and increase boiler operating efficiency at its Plant No. 1, San Diego, California.

Rapid expansion just prior to and during World War II was responsible for the original segregated power facilities. The plant was established in 1935 with the erection of one building of 225,000 sq ft area, and a small boiler plant. Subsequent expansion resulted in the present plant, consisting of twelve main and over 50 auxiliary buildings, having a combined area of 1.8 million sq ft. During the same period twenty-two boilers were installed, in five different locations, to serve the process and heating loads, of 20 and 80 per cent.

Although this was the fastest and most opportune arrangement at the time, it left much to be desired in the way of convenience and economies during normal production years. Thus, in 1953 a study was authorized to determine the best procedure for a planned modernization program.

The survey covered such pertinent facts as condition of existing facilities; cost of overhauling and augmenting existing equipment; cost of a replacement program; and operating savings to be obtained from a completely new centralized boiler plant, over and above the costs of the existing installation.

Results of the study indicated that a new centralized plant would pay for itself in approximately five years. With this recommendation from the power engineers, management authorized the modernization program, with the stipulation that it be spread over a 3-year period.

Both design and construction were performed by the company's engineers. One of the old boiler houses was selected as the site of the new central plant. The four old boilers were removed and two new ones installed the first year; another one the second; and two more the third year. These are 125 psi, 40,000 lb per hour, saturated steam, waterwall furnace, 3-drum, split section, pressurized furnace, package-type units. Oil or gas can be used as fuel.

Each boiler is equipped with manually operated soot blowers, feedwater regulators, and combustion control. Boiler load and fuel flow are controlled directly from an indicating

*Senior Plant Design Engineer, Convair Division, General Dynamics Corp.

master steam-pressure controller, a full adjustable-range, direct-set type proportional instrument. It holds the steam pressure within a narrow control band.

Plant Operation Now Automatic

In operation, air output loading from the master controller simultaneously readjusts air and fuel flow. A bias adjustment of the master-loading permits shifting the load between multiple boilers supplying a common header. A combining relay combines the master controller signal changes, with the air flow signal in derivative form, so that air flow is increased or decreased temporarily by the master controller on every load change. A component controller balances steam and air flow signals in the correct predetermined ratio.

The water level in each boiler is controlled by a two-element regulator, actuated by drum level and steam flow. Simple adjustments provide for a rising, a lowering, or a practically-constant drum water level on an increasing boiler load.

Centralizing the boilers necessitated rearrangement of several 15-psi steam lines for use in 120-psi service, and the installation of pressure-reducing stations at the building distribution centers. New steam lines were installed where needed, as was a new condensate return line. Six of the old condensate return pumps were converted for higher pressure, and an additional one installed.

Where possible, existing monorail structures and bridges were used to support new distribution piping. Three main buildings were dead-ended, and the reducing valves were placed in the boiler house, to eliminate the costly conversion of existing tunnelled distribution piping. For one of these buildings, the pneumatic pilot and relief valve were placed at the building header. The pipeline, which was undersized for 15 psi, served as a reducing orifice downstream from the reducing valve.

All line trap discharges are connected to the pumped condensate lines. To avoid water hammer the discharge pipe was swaged to a nozzle end, bent to a 45 deg angle, and inserted inside the condensate line.

Junior bridge cranes were erected for the installation of two reducing stations inaccessible to a truck crane. These were left in place for future maintenance work. All other piping was erected with a truck crane, or rolled along the roof tops. The 3-year job was completed without a single lost time accident.

Improvements resulting from the modernization program provided for new production methods, as well as increased operating efficiency. Some of the outstanding results are:

1. Capacity increased from operation at 50 per cent load factor in 1953, to 100 per cent with a surplus capacity of 20 per cent in 1957.

2. Operating efficiency is now 81 per cent, as compared with an efficiency of 62 per cent in 1953.

3. Operating personnel reduced from 24 in 1953 to the present 9.

4. All buildings are now effectively heated. Cold zones have been eliminated.

5. New processes, requiring the higher pressure steam (high-temperature cleaning, scotch welding, and metal bonding), have been introduced.

6. Heating equipment using gas or electricity is being converted to steam.

7. Plans are being prepared to use steam operated refrigerating equipment. This will improve the year-round use factor. THE END

Principal New Plant Equipment

Boilers	Wickes Boiler Co
Boiler Feed Pumps	Fairbanks-Morse Co
Combination Burners	Leahy Manufacturing Co
Feedwater Regulators, Combustion Control, Soot Blowers	Copes-Vulcan Division, Blaw-Knox Co
Hot Process Water Softener	Permutit Co

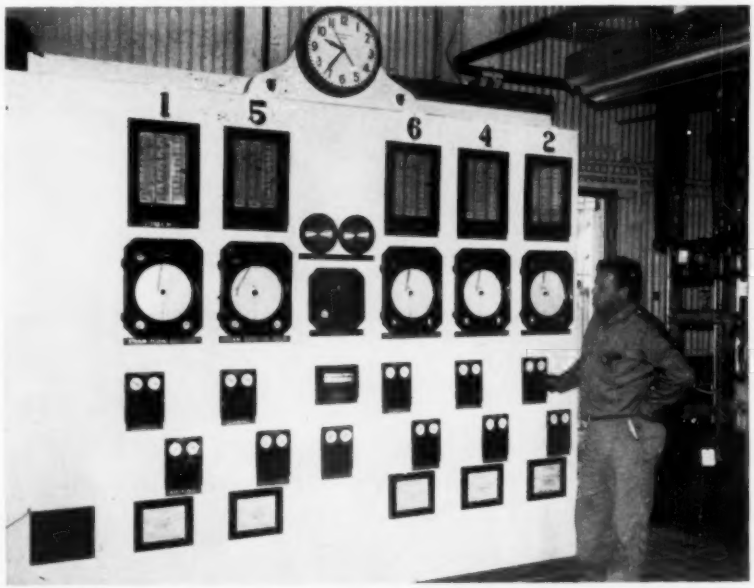


Fig. 3. Central panel in the boiler room contains combustion control instruments such as master controller, steam-air flow recorders, and bias loading stations

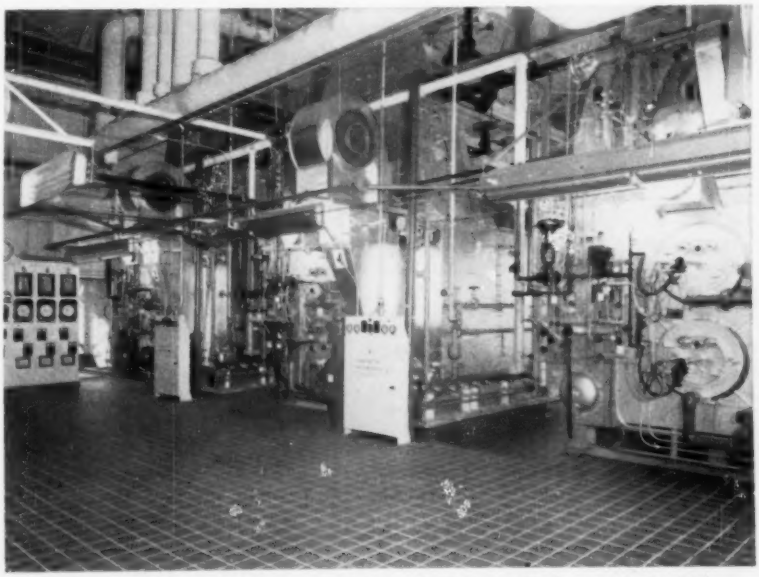


Fig. 4. Each of the five boilers is equipped with combustion control which can be switched from oil to gas firing, or vice versa, with minor adjustments for each

Fig. 1. Left. General view of speakers' table at President's Luncheon, December 2, 1957 annual ASME meeting, Hotel Statler, New York. Outgoing ASME President William F. Ryan spoke on The Blind Spot, the older engineer's oversight of the need for cultivating professional attitudes in younger men

ASME Holds Annual Meeting at New York

MARKED by intense interest in over 400 technical papers, and in the customary program of speeches by outstanding engineers in the field, the American Society of Mechanical Engineers annual meeting was held December 1 to 6, 1957, at Hotel Statler and Hotel Sheraton-McAlpin in New York City.

Of principal interest to power engineers were very practical papers and discussion on gas turbines, nuclear power, coal evaluation, new data on stokers and pulverized coal, water treatment, instrumentation, and use of computers and "electronic" brain systems.

New concepts in stokers interested many of the members. F. C. Messaros and F. C. Belsak explained a new stoker in which the grate consists of block-covered cooling tubes connected into the boiler circulation. The blocks have tuyeres to admit air, the grate is inclined 14 deg, and the whole assembly is vibrated by a vibration generator. Coal is fed at the high end, the vibration feeds it down the grates and the ash discharges at the rear.

Paul O. Kock also described the development of a vibrating grate stoker, which is part of the development of the Bituminous Coal Research automatic coal-fired steam generator.

Development and operating experience of the jet-injection stoker were detailed by N. W. Young. This is a chain grate stoker with new design of both undergrate and overfire air supply, designed to permit close control of combustion conditions. No arches are required. Young reported on: the types and sizing of coals that can be burned on this stoker; the excess air and power requirements; and the combustible loss and other operating factors.

Advantages of solar furnaces for

Fig. 2. Below. At annual business meeting of ASME, Willis Thompson showed this model of proposed new headquarters building for entire engineering profession, to be built by United Engi-

neering Trustees, Inc on United Nations Plaza. For this project, UET has already purchased land. Completion due 1960

Fig. 3. C. E. Davies, ASME secretary for 23 years, makes retirement speech at annual banquet; joins UET group

research, as reported by P. E. Glaser, include: attainment of temperatures of over 6000 F; heat focused in small area; atmosphere that can be controlled, unlike fuel-fired furnaces. Also, a refrigerator, for use in remote locations, can be built using the absorption principle with the heat derived from solar rays, according to Chung, Williams, Lof, Fester and Duffie.

Innovations in incinerator design, as exemplified in a new incinerator plant at Oyster Bay, Long Island, were described by W. Raisch. These include hydraulic ash handling, waste-heat steam and electric power generation, low-pressure steam and water fly-ash removal, centralized control board, radiant heating in charging floor.

W. T. Batcheller, discussing economics of heating and power systems for large industrial plants, analyzed in detail the power and steam loads of a specific plant. He showed how a program could be included for processing available sub-bituminous coal to yield its by-products, the sale of which aids in reducing costs of producing steam and power.

Steam from by-product fuels, such as char, coke, pitch, and wood, bagasse and others was covered by J. B. Walker, Jr. Steam from by-product industrial gases, by use in waste heat boilers, as for utilizing gas turbine exhaust, cement kilns, ore roasters and the like, was treated by F. G. Raynor.

Unusual method of handling coal on the Public Service system, utilizing an outdoor active storage pile feeding to 4-hr bins inside, over each of 5 pulverizers, was detailed by R. A. Baker.

Schalifer, Strout and Land discussed application of bonus-penalty method to coals being purchased or evaluated. H. B. Lammers analyzed utility fuel records and operating costs and concluded that the notion that coal should be bought on a cost-per-million Btu basis is not satisfactory, that comparative fuel costs should include the incremental costs, which he illustrated by data from a 160,000-kw unit.

Much interest was evoked by numerous papers on the gas turbine, the steam turbine, and particularly their uses in nuclear power plants. The land gas turbine, said Jacobs and Landes, offers the simplicity of a self-contained prime mover. But accessories such as ductwork, filters, silencers, starters, cooling devices and fuel handling must be wisely incorporated to insure best performance.

Combined gas-turbine-steam-turbine cycles with supercharged boiler and its fuels were reviewed in detail by A. O. White. Cataldi, Cheng and Musick reported on tests for evaluating resistance of various turbine materials to wet oxygenated steam, such as that from a boiling water reactor. Ohlgren and Hammitt reported on economic optimizations for components of nuclear-powered closed-cycle gas turbine power plants.

John Parmakian showed how one-way, low-level surge tanks may be used for the control of water hammer in pumping plants, in case water separation occurs in the discharge if the pump motors fail.

Diet for boiler allergies, stressing the advantages and limitations of the coördinated phosphate-pH control method, was treated by S. F. Whirl. Ammonia and hydrazine for high-pressure boilers, and their satisfactory use in 6 boilers in the Public Service Electric & Gas system, were detailed by R. I. Smith. Effect of mechanical factors on condensate-system corrosion, and the ways in which sound engineering in system design can reduce this corrosion, were explained by Dalbke and Wilkes.

Continuous monitoring equipment for power plant cycles, using modern instrumentation for collecting performance information and computers for analyzing the information and obtaining best performance of the plant under full automatic control were explained by Imsland and Hornfeck. New type of flow straightener, using separated plates, and designed to provide a new accuracy of flow measurement in any piping system, was explained by Sprenkle and Courtwright.

Besides the technical sessions, the meeting included the usual special events such as luncheons of the various divisions, the annual banquet, a special entertainment program for the ladies, inspection trips and college re-unions. The accompanying pictures show some of these events.

James N. Landis of Bechtel Corp. was inducted as president of ASME for 1958, succeeding 1957 President William F. Ryan of Stone & Webster Engineering Corp. THE END

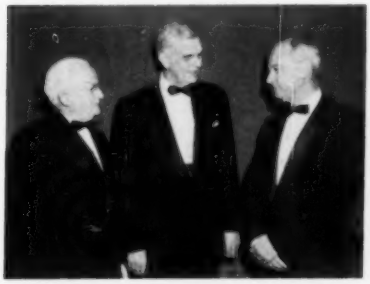


Fig. 4. L to r—Outgoing ASME President W. F. Ryan, banquet speaker Henry T. Heald, incoming president J. M. Landis

Fig. 5. President Ryan introduces ASME Director Frank L. Bradley at President's Luncheon on first day of annual meeting

Fig. 6. President Landis awards honorary membership to E. G. Bailey, while J. S. Morehouse, board on honors, watches

Fig. 7. ASME registration lobby at Hotel Statler was scene of continuous activity, as members renewed old acquaintances

Fig. 8. Dean L. M. K. Boelter of UCLA receives ASME medal from President Landis for achievements in education

Fig. 9. Members crowded ASME preprint booth for technical papers, also display of various Society publications

Power Engineering handbook

Boiler Water Treating Systems

Factors to be considered in the selection of water-treating equipment. A review in two parts. . . Part 1

By T. L. PANKEY *

EXTREMELY RAPID advances in water treating technology, particularly in the field of ion exchange, have resulted in a profusion of detailed information on types of equipment and their operation. At the same time the problem of proper selection of equipment on an engineering and economic basis has become more complex and difficult. With such a situation in mind, this discussion will be directed toward defining water treating requirements and examining the adequacy of various types of equipment to meet those requirements.

Every power plant operator is confronted with the problems of preventing deposits in boilers and turbines, corrosion in boilers, turbines and condensate return lines, and of controlling carry over without excessive blowdown. Severity of these problems will depend upon the character of the water available, the type of steam generating equipment used, pressure and temperature of steam generation, percentage of make-up, and the use to which the steam is put.

Throughout the United States water sources will vary greatly. In the Mississippi Valley we can expect surface waters of moderate hardness and well waters of very high hardness, usually accompanied by high alkalinity, and fair amounts of silica. In New England and in the Pacific Northwest the waters available will usually be relatively low in hardness and high in silica. In the Rocky Mountain area we may find snow run-off waters of low solids content, but may also find waters having quite high dissolved solids. In the Gulf States the hardness of the waters usually is low, but the alkalinity and silica will be very high.

Sodium Zeolite

There are a number of basic cycles or methods available for treating these waters. The old and familiar sodium zeolite treatment is the simplest and least expensive (Fig. 1). In this cycle, calcium and magnesium, which represent the hardness constituents of the water and which will cause scaling and deposits in boilers, are exchanged in an equivalent amount for sodium to produce a water of practically zero hardness.

Since the process is one of simple exchange there will be no reduction in the amount of total solids in the water. There will likewise be no decrease in the amount of alkalinity in the water nor in the silica present. If these constituents are of importance in the operation of the boiler, other means of treatment must be employed. The simplicity of operation and the low cost of this method of treatment, however, make sodium zeolite treatment a process which should receive

* From a paper given at the annual meeting of NAPE in 1957. Mr. Pankey is associated with the Allis-Chalmers Mfg Co.

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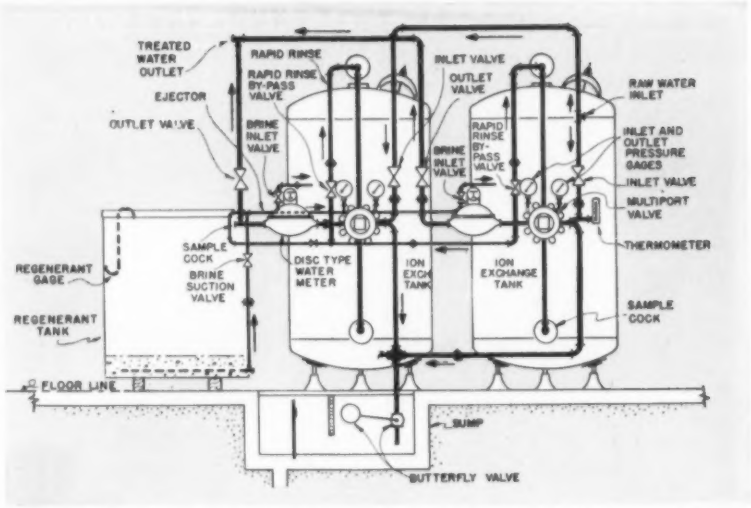

Fig. 1. The old and familiar sodium zeolite treatment is still the simplest and the least expensive method

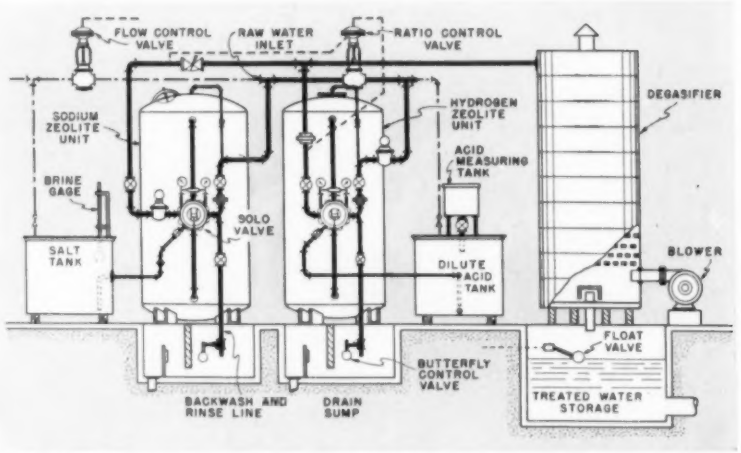

Fig. 2. When hydrogen zeolite treated water is blended with sodium zeolite treated water, the resulting effluent from the system has zero hardness and very low alkalinity, but silica is unaffected by this treatment

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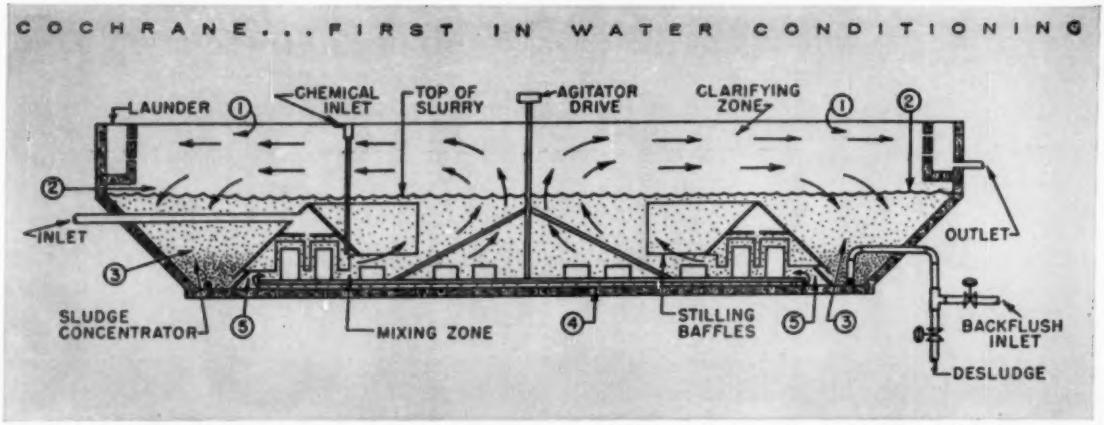
COCHRANE . . . FIRST IN WATER CONDITIONING



A **Cochrane** solids contact reactor is designed to provide the ultimate in clarification

Cochrane suspended solids contact coagulating and softening clarifiers are packaged units that combine a mixing zone at the bottom with a clarifying zone above.

A bottom agitator in the mixing zone keeps old precipitates in constant suspension. Thorough mixing and contact between the old and new precipitates is thus assured. This results in a more complete reaction with a minimum in chemical requirements and retention time. In the clarifying zone the water is effectively separated from the slurry precipitates and clarified.

The Cochrane reactor design is unique in its baffle and agitator arrangement, as follows:

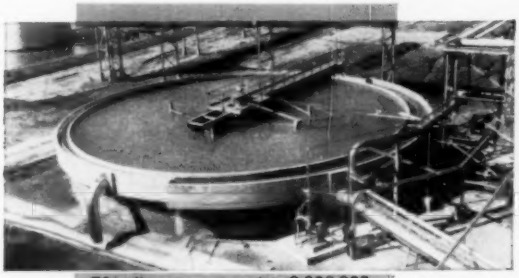
① Radial *Horizontal* Flow—*Not Upflow*. Velocity decreases from center to launder. Slurry particles separate more efficiently from horizontal flow than from upflow.

② Slurry flow is *downflow* in clarifying zone below collecting launders—*not upflow*—thus preventing carryover of turbidity into effluent.

③ Sludge settles only in annular *concentrator* outside of mixing zone. Maximum concentration results because no turbulence is present. This feature saves wastage of water in desludging.

④ There is no premature loss of slurry strength in mixing zone because no sludge settles on the floor of mixing zone.

⑤ Turbulence in mixing zone assures excellent mixing. A large, full-diameter agitator causes centrifugal outward flow, against the diverting baffle in front of the outer port and turns flow inwardly towards central port.



72' diameter, capacity 9,000,000 GPD located in Georgia.

72' diameter, capacity 9,000,000 GPD located in Texas.

Two units 82' diameter—capacity 20,000,000 GPD located in Washington.

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prime consideration for use in at least part of the treating cycle.

With the development of resinous-type zeolite exchange media it became possible to regenerate the zeolite material with sulphuric acid to produce a hydrogen-bearing medium as well as a sodium zeolite material (Fig. 2). When water is passed through a hydrogen zeolite resin, calcium, magnesium and sodium are exchanged for hydrogen to form the corresponding acids. Carbonic acid is formed and this acid readily breaks down to its constituents of water and carbon dioxide so that it is possible to effect a release of carbon dioxide, thus reducing the alkalinity in the water.

When this hydrogen zeolite treated water is blended with a sodium zeolite treated water, the resulting effluent from the system has zero hardness and very low alkalinity, and decreased total dissolved solids. Silica will, however, be unaffected by this cycle of treatment. A typical analysis would be: hardness 0 to 1 ppm, alkalinity 15 ppm.

If total dissolved solids in the raw water are low, and high alkalinity and hardness are the only problems, the water can be treated by passing it through a sodium zeolite softener and then through an anion exchanger regenerated with sodium chloride. The effluent from this system will have low hardness and the alkalinity will be mostly replaced by chlorides (Fig. 3).

Hot Process Lime Soda

Hot process lime soda treatment is based upon the principle of precipitating calcium and magnesium by means of lime and soda ash. In this process calcium and magnesium are reduced and there is a reduction of alkalinity. It is also possible by use of the proper chemicals and methods of operation to bring silica easily to about 2 ppm and with special care to about 1 ppm. A typical analysis from a hot process lime soda softener would be hardness 17 ppm, alkalinity 50 ppm, and silica 2 ppm.

While hot process lime soda softening systems have served many plants for a number of years, the limitation of approximately 17 ppm hardness in the effluent was severely felt. In a number of plants where a lower hardness feedwater was required, hot process lime soda softening was supplemented by

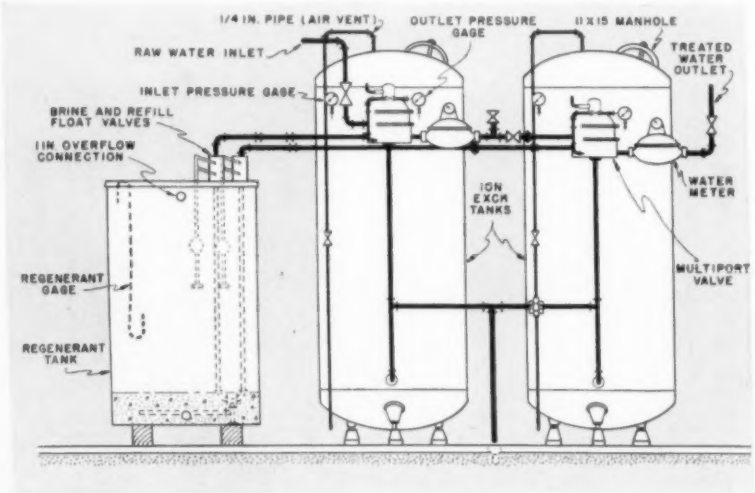

Fig. 3. If high alkalinity and hardness are only problems, and total dissolved solids in water are low, sodium zeolite softener can be used, then water passed through exchanger regenerated with sodium chloride

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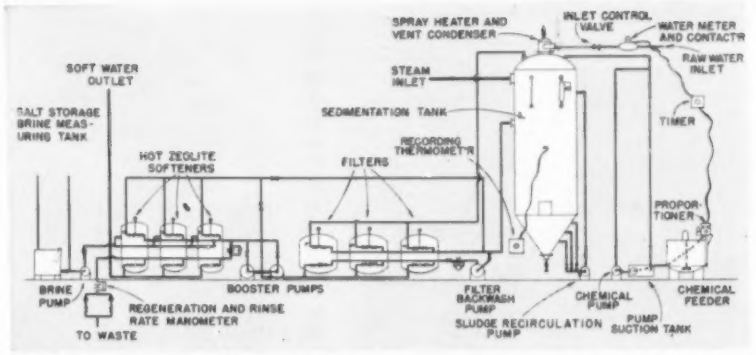

Fig. 4. Hot lime-hot zeolite system combines best of hot process softening and sodium zeolite treatment

phosphate softening in a separate stage in series with the lime soda softener. There are plants operating on this cycle very satisfactorily at boiler pressures up to 900 lb with 100 per cent make-up.

Hot Lime-Hot Zeolite

Today there are practically no plants being set up to operate with a hot process lime soda softener in series with a phosphate softener due to the development of a very much more effective hot lime-hot zeolite cycle (Fig. 4).

In this cycle, lime only is fed to the hot process softener to reduce the carbonate hardness and alkalinity of the water. No soda ash, or very little, is fed to reduce the non-carbonate hardness. The hot lime softener, which physically is built exactly the same as the hot process lime soda softeners, is followed by zeolite softeners in which the residual hardness is brought down to 1 ppm with cut-off points at 2 ppm.

This cycle of operation thus combines the best characteristics of hot process softening and of sodium zeolite treatment. Alkalinity, hardness, and silica are reduced in the hot lime sedimentation tank and the residual hardness is treated by means of zeolite exchange using inexpensive lime and salt. Not only is it possible to secure a very low hardness by means of this cycle, but since soda ash is not fed in the excesses required for normal hot process softening, it is possible to reduce the alkalinity to a lower level. A typical analysis from a hot lime-hot zeolite softener would be hardness 1 to 2 ppm, alkalinity 25 ppm, silica 2 ppm.

Demineralization

The newest and most rapidly developing cycle of treatment is known as demineralization. In this process calcium, magnesium and sodium are exchanged for hydrogen, and the chlorides, sulphates, bicarbonates and silica are exchanged for hydroxide with a combination of the hydrogen and hydroxide in the effluent to produce a pure water. Practically speaking, no chemical reaction can be carried to absolute completion, so there will be a small residual amount of dissolved solids in the effluent.

It is easily possible, however, to limit this amount of residual solids to 5 ppm or less with silica at 0.02 ppm. It can be seen that the jump upward in quality of water produced is very sharp and marked. Due to the high cost of the exchange resins and chemicals required, and the protective linings and metallurgy required for protection of equipment from the effects of acid and caustic solutions, the expense in initial investment and operation is correspondingly high.

In Part 2 of this discussion, to appear next month, we will continue these remarks on demineralization, and go on to analysis of water treatment in relation to boiler types, and other aspects.

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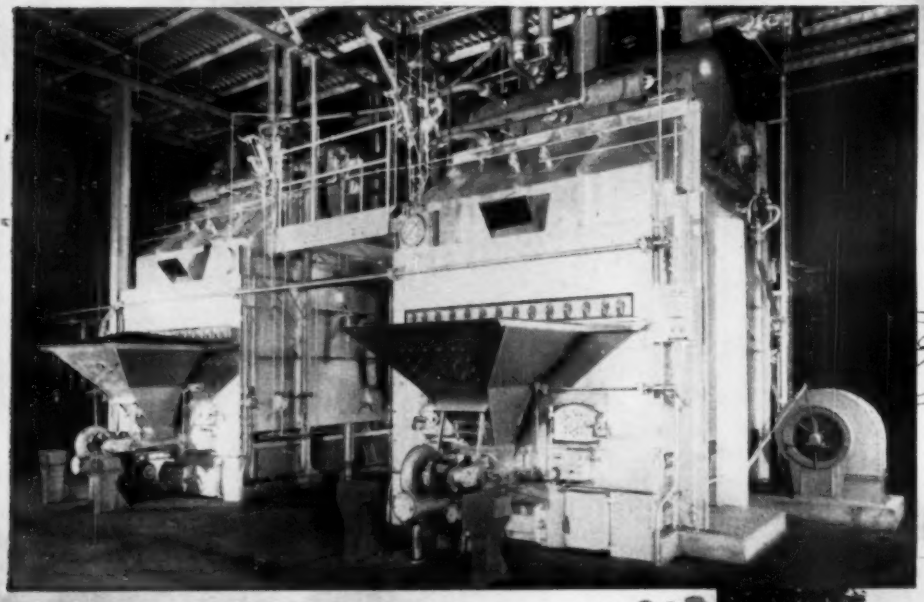
DETROIT STOKERS HELP REDUCE COST OF STEAM AT PINEHURST

The Detroit Stoker Equipped Steam Plant at this Famous North Carolina Resort Serves three Hotels, seven other buildings



Steam Plant, Pinehurst, Incorporated, showing Detroit Single Retort Stokers. Boilers are Babcock & Wilcox Integral Furnace Type FF.

John F. Taylor, *Manager Utilities* . . .
Wiley & Wilson, *Consulting Engineers*, Richmond, Va.

The Carolina Hotel, Pinehurst, N. C.— the largest of the three hotels served by this modern plant.

Cost of steam per thousand pounds has been reduced 33.4% by the new stoker — boiler installation, according to Mr. John F. Taylor, Utilities Manager, Pinehurst, Incorporated, Pinehurst, N. C. Amount of steam generated per pound of coal has been increased 22%.

The stokers are Detroit Single Retort Underfeed motor driven . . . the boilers are B&W Integral Furnace Type FF. A master regulator is connected to the Detroit Adjustable Feed Control on each stoker and to the adjustable damper of each motor-driven fan to regulate fuel and air in proportion to the load.

Detroit Underfeed Stokers provide high efficiency at low operating cost with small and medium size boilers.

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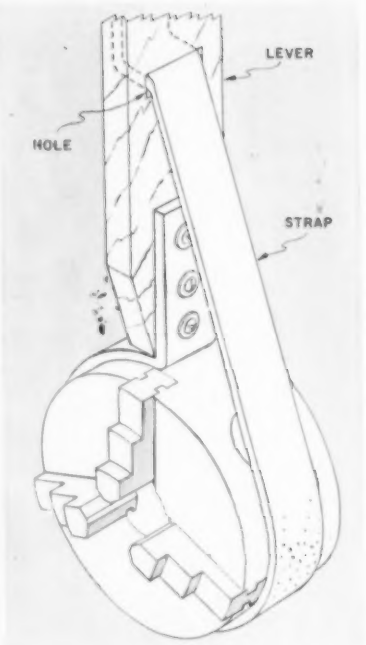


Belting is wrapped around chuck body and loose end fed through the slot. Jerk loosens the chuck

1 Small Chuck Loosener

HERE'S A TOOL which can be made up in quantity for loosening the chucks mounted on the screwed spindles of small lathes.

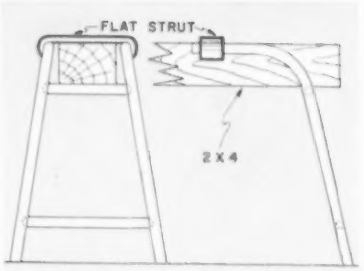
The tool comprises a leather strap made from old belting secured by screws and washers to one end of a wooden lever. The lever has a slot cut in it.

In use, the belting is wrapped around the chuck body and the loose end fed through the slot. The loose end is gripped in firm contact with the back face of the lever with one hand and a quick jerk will usually loosen the chuck.

When chucks are tight on the spindle, there is a tendency for the leather strap to slip through the hole in the lever. In such cases, pushing a wooden wedge into the hole anchors leather to lever.

4 More Practical Ideas for You

from F. E. RILEY



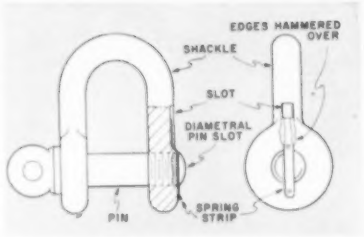
No tools are needed to erect or dismantle trestles

2 Useful Trestle Legs

TRESTLE LEG illustrated is made from welded steel tubing, and a pair of them, together with a length of 2 by 4 timber, forms a strong trestle. With two trestle assemblies, strong working platforms can be erected quickly for painting, erecting machinery and other maintenance duties.

Each leg is made from two bent pieces of steel tubing with two tubular horizontal struts and a single flat steel strut at the top, all welded in place. It will be apparent from the sketch that no tools are needed in erecting or dismantling the assembled trestles, which can be of any length, according to the length of the piece of timber used.

The legs stack in a compact pile and the average man can carry six of them, three on each shoulder, up a ladder. A useful height is 2 ft, but others have been made up to a height of 5 ft 6 in.



Way to make shackle pins self-locking without need for extra tools. End faces of pins are slotted

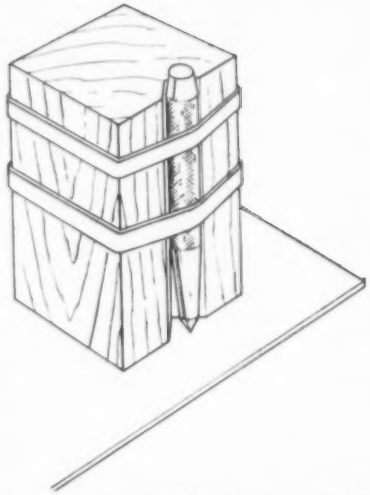
3 How to Make Shackle Pins Self-Locking

SCREWED-IN shackle pins require a bar for insertion through the eye in order to tighten or undo them. If the bar is not available, the maintenance men will tend to tighten the pins with the fingers only. The pins can slowly unscrew themselves from the shackles, since the threads are of coarse pitch and are usually a very easy fit.

Shackle pins can be made self-locking without the need for extra tools by adopting the idea shown in the sketch. The end faces of the pins are slotted, an average width being $\frac{1}{4}$ in. A piece of strong spring steel strip is fitted to the shackle and arranged to intersect the pin diameter. When the pin is screwed through the threaded leg of the shackle, it first pushes on the spring steel strip. Another half turn of the pin results in the strip jumping into the diametral slot in the pin end and prevents further rotation.

To undo the pin, the bottom part of the spring strip is lifted with the thumbnail clear of the slot in the pin end. The pin can then be unscrewed. The device has proved itself efficient with one engineering firm which does a great deal of heavy machinery lifting with shackles as part of the tackle.

A standard shackle is fitted with the spring strip by milling a shallow slot to take the strip, which is then locked in place by riveting or peening over the metal at the slot edges.



Punch is held to block by rubber bands. Block can be slid rapidly over work from point to point

4 Punch Holder Eases Marking-Out Process

MARKING OUT the screw holes for sheet steel cladding which has to be fixed to frameworks will be done quicker and more accurately if the center punch is mounted in a holding block.

V-groove is cut in the vertical face of a wooden block and the punch rests in this. The punch is secured loosely to the block by means of a pair of thick rubber bands.

On a horizontal work surface, the wood block can be slid rapidly from one hole location to another and the punch hammered into contact with the surface without danger of hitting the fingers. The convenience of the punch holder lies in the larger grip provided for the left hand, and the fact that the punch is always ready for use and does not lie down.

The punch used in this way never has to be picked up in the fingers.

fold along this line—outside edges toward you

cut along this line

why take chances?

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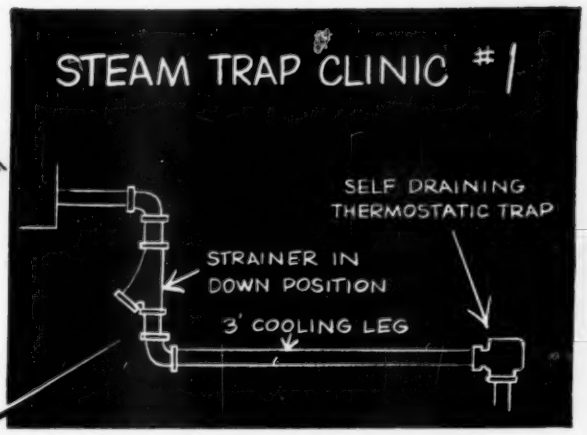

how to hook up a non-freeze installation

Here is the piping layout recommended for outdoor service where a freeze-proof trap installation is required. First, install the strainer used to protect the vital working parts of the steam trap in a down position, so that condensate will not collect and freeze in the strainer body. Second, use a cooling leg of three feet or more. This is important because thermostatic traps recommended for this service operate on temperature differential. Third, use a trap with a constant downward flow that eliminates any possibility of condensate collecting in the trap and later freezing and damaging the working parts. Anderson Quik-Flex Industrial Thermostatic Steam Traps fulfill these non-freeze requirements. The only trap guaranteed freeze-proof for two years, these traps open instantly upon contact with cold air or condensate. Their downflow type design keeps condensate flowing out of the trap so that it cannot freeze as it cools. Mail coupon for complete details.

ANDERSON *QUIK-FLEX* STEAM TRAPS

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
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Please send additional information on Anderson freeze-proof Quik-Flex Thermostatic Steam Traps.

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Company _____

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Guaranteed Not to Freeze

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Handy Tables for Pipefitters

ALLOWANCE FOR CENTERS OF FITTINGS

	⅛"	¼"	⅜"	½"	⅝"	¾"	⅞"	1"
90° Ell.	5/16"	5/16"	5/16"	5/16"	½"	13/16"	1⅛"	1¼"
Tee	5/16"	5/16"	5/16"	5/16"	½"	13/16"	1⅛"	1¼"
Str. Ell.	5/16"	5/16"	5/16"	5/16"	½"	13/16"	1⅛"	1¼"
Th'd End Str. Ell.	½"	1 1/16"	1 1/16"	1 1/16"	1 11/16"	2"	2 5/16"	2 1/16"
Union	5/16"	½"	½"	1"	1 1/16"	¼"	1 5/16"	1 5/16"
Cplg.	5/16"	¼"	½"	½"	½"	⅞"	½"	5/16"
45° Ell.	¼"	5/16"	⅜"	½"	½"	⅞"	1 1/16"	¼"

	2"	2½"	3"	3½"	4"	4½"	5"	6"
90° Ell.	1½"	1¾"	2 1/16"	2 5/16"	2 11/16"	—	3 5/16"	3 13/16"
Tee	1½"	1¾"	2 1/16"	2 5/16"	2 11/16"	—	3 5/16"	3 13/16"
Str. Ell.	1½"	1¾"	2 1/16"	2 5/16"	2 11/16"	—	3 5/16"	3 13/16"
Th'd End Str. Ell.	3"	3 13/16"	4 1/16"	—	—	—	—	—
Union	1½"	1 13/16"	2 1/16"	2 5/16"	2 11/16"	—	—	—
Cplg.	1½"	1"	1 1/16"	—	—	—	—	—
45° Ell.	1"	1¼"	1 5/16"	1 5/16"	1 11/16"	—	1 15/16"	2 5/16"

ALLOWANCE FOR LENGTH OF THREAD FOR VARIOUS PIPE SIZES

LENGTH OF THREAD ON PIPE

Size Inches	Dim. "A" Inches	Size Inches	Dim. "A" Inches	Size Inches	Dim. "A" Inches	Size Inches	Dim. "A" Inches
⅛	¼	1	5/16	3	1	6	1¼
¼	⅜	1¼	5/16	3½	1 1/16	7	1¼
⅜	⅜	1½	5/16	4	1 1/16	8	1 3/16
						9	1 3/16
½	½	2	1 1/16	4½	1 1/16	10	1½
¾	¾	2½	1 5/16	5	1 5/16	12	1½

SOCKET SIZES

Socket	S.A.E.	U.S.S.	Cap Scr.	Socket	S.A.E.	U.S.S.	Cap Scr.
5/16	—	⅛	⅛	1 1/16	⅜	⅛	—
⅜	—	—	3/16	1 1/8	—	—	⅞
7/16	¼	—	¼	1 1/4	⅞	¾	1
½	5/16	¼	5/16	1 3/8	—	—	1 1/8
5/16	⅜	—	⅜	1 7/16	—	⅞	—
19/32	—	3/16	—	1½	—	—	1¼
⅝	7/16	—	7/16	1 5/16	1⅛	1	—
11/16	—	⅜	—	1 13/16	1¼	1 1/8	—
¾	½	—	½	2	1 3/8	1¼	—
23/32	—	7/16	—	2 1/16	1½	1 3/8	—
13/16	—	—	9/16	2 1/8	—	1½	—
⅞	9/16	½	⅝	2 3/16	—	1 3/4	—
15/16	⅝	—	—	2 1/16	—	1⅞	—
31/32	—	9/16	—	3½	—	2	—
1	11/16	—	¾	—	—	—	—

DIMENSIONS OF GASKETS

STANDARD AND LOW PRESSURE FLANGES					MEDIUM AND EXTRA HEAVY FLANGES				
SIZE OF PIPE	RING GASKETS		FULL FACED GASKETS		SIZE OF PIPE	RING GASKETS		FULL FACED GASKETS	
	I.D.	O.D.	I.D.	O.D.		I.D.	O.D.	I.D.	O.D.
¾"	¾"	2⅛"	¾"	3½"	1"	1"	2⅞"	1"	4⅛"
1"	1"	2⅜"	1"	4½"	1¼"	1¼"	3¼"	1¼"	5¼"
1¼"	1¼"	3"	1¼"	4⅞"	1½"	1½"	3¾"	1½"	6⅛"
1½"	1½"	3⅜"	1½"	5"	2"	2"	4⅜"	2"	6½"
2"	2"	4⅛"	2"	6"	2½"	2½"	5⅛"	2½"	7½"
2½"	2½"	4⅞"	2½"	7"	3"	3"	5⅞"	3"	8¼"
3"	3"	5⅜"	3"	7½"	3½"	3½"	6½"	3½"	9"
3½"	3½"	6⅜"	3½"	8½"	4"	4"	7⅛"	4"	10"
4"	4"	6¾"	4"	9"	4½"	4½"	7¾"	4½"	10½"
4½"	4½"	7"	4½"	9¼"	5"	5"	8½"	5"	11"
5"	5"	7¾"	5"	10"	6"	6"	9⅞"	6"	12½"
6"	6"	8¾"	6"	11"	7"	7"	11"	7"	14"
7"	7"	10"	7"	12½"	8"	8"	12⅛"	8"	15"
8"	8"	11"	8"	13½"	9"	9"	13"	9"	16¼"
9"	9"	12½"	9"	15"	10"	10"	14¼"	10"	17½"
10"	10"	13⅜"	10"	16"	12"	12"	16⅜"	12"	20½"
12"	12"	16⅛"	12"	19"	14"	14"	19⅛"	14"	23"
14"	14"	17¾"	14"	21"					

fold along this line—outside edges toward you

TABLE OF WATER HEADS AND EQUIVALENT PRESSURES

To Estimate any Pressure Multiply the Head (in feet) By .4333
The Result is Pounds Per Square Inch.

Head-in Feet	Pressure—Lbs. Per Sq. In.	Head-in Feet	Pressure—Lbs. Per Sq. In.	Head-in Feet	Pressure—Lbs. Per Sq. In.	Head-in Feet	Pressure—Lbs. Per Sq. In.
5	2.17	60	26.00	250	108.33	500	216.67
10	4.33	70	30.33	275	119.17	550	238.33
15	6.50	80	34.67	300	130.00	600	260.00
20	8.67	90	39.00	325	140.83	650	281.67
25	10.83	100	43.33	350	151.67	700	303.33
30	13.00	125	54.17	375	162.49	750	325.00
35	15.17	150	65.00	400	173.33	800	346.67
40	17.33	175	75.83	425	184.16	850	368.33
45	19.50	200	86.67	450	195.00	900	390.00
50	21.67	225	97.50	475	205.83	950	411.67
						1000	433.33

DRILL SIZES FOR PIPE TAPS

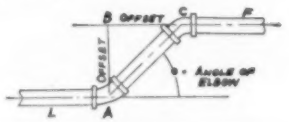
Size of Tap	Briggs Standard		Size of Tap	British Whitworth	
	Thread	Drill		Thread	Drill
⅛	27	21/64	⅛	28	5/16
¼	18	27/64	¼	19	7/16
⅜	18	9/16	⅜	19	9/16
½	14	11/16	½	14	23/32
			⅝	14	25/32
¾	14	29/32	¾	14	29/32
			⅞	14	1 1/16
1	11½	1⅛	1	11	1 5/32
1¼	11½	1 5/32	1¼	11	1 1/2
1½	11½	1 23/32	1½	11	1 23/32
			1¾	11	1 31/32
2	11½	2 5/16	2	11	2 5/16
			2¼	11	2 13/32
2½	8	2 5/16	2½	11	2 23/32
			2¾	11	3 1/32
3	8	3 5/16	3	11	3 5/32
			3¼	11	3 1/2
3½	8	3 11/16	3½	11	3 3/4
			3¾	11	4
4	8	4 5/16	4	11	4 1/4
4½	8	4 11/16	4½	11	4 3/4
5	8	5 1/4	5	11	5 1/4
			5½	11	5 3/4
6	8	6 5/16	6	11	6 1/4

HAND TAPS FOR BOLTS

Tap	Thread Series	Dia. Hole	Drill	Tap	Thread Series	Dia. Hole	Drill
⅛	40	.101	38	9/16	18NF	.516	33/64
5/32	36	.129	30	5/16	12NC	.484	31/64
3/16	24	.147	26	⅝	18NF	.578	37/64
7/32	24	.177	16	⅝	11NC	.531	17/32
¼	28NF	.213	3	11/16	16NF	.625	⅝
¼	20NC	.201	7	11/16	11NC	.594	19/32
5/16	24NF	.272	1	¾	16NF	.688	11/16
5/16	18NC	.257	F	¾	10NC	.656	21/32
⅜	24NF	.332	Q	⅞	14NF	.813	13/16
⅜	16NC	.313	5/16	⅞	9NC	.766	49/64
7/16	20NF	.391	25/64	1	14NF	.938	15/16
7/16	14NC	.368	U	1	8NC	.875	⅞
½	20NF	.453	29/64	—	——	—	—
½	13NC	.422	27/64	—	——	—	—

TABLE OF CONSTANTS FOR FINDING DISTANCE BETWEEN ELBOW CENTERS

There are Elbow Angles other than 45°; such as 60°, 30°, 22½°, 11¼°, and 5⅝°. For such, the Distance between Elbow Centers can easily be found by use of the following Table of Constants:



ELBOW CONSTANTS

Angle of Elbow	Elbow Center AC	Offset AB
60°	1.15	.58
45°	1.41	1.00
30°	2.00	1.73
22½°	2.61	2.41
11¼°	5.12	5.02
5⅝°	10.20	10.15

FORMULA

AC = Offset AB x Constant for AC

BC = Offset AB x Constant for AB

Allow deductions of Elbows for length of projections.

Compiled and reprinted courtesy of Bill Noe, pipefitter foreman at Laclede Steel Co, and of Armstrong Trap Magazine

cut along this line

Unique Combination

continued from page 68

energy-balance method, and the so-called conventional method. Selection may be made from one to the other by transfer switch, but it is expected that the direct energy-balance method normally will be used.

With the direct energy-balance method, the input of fuel to the furnace is directly regulated by the unbalance between the required output and the actual generator output, the air by generator output, and the turbine governor controlled to maintain steam pressure. The energy input to the furnace is directly controlled to give the desired generator output and the turbine keeps in step with the steam-generator output.

So-called conventional method regulates the turbine governor to give required generator output while the energy input to the furnace is controlled to maintain steam pressure. Combustion-rate anticipation is obtained from generator output plus regulation applied to turbine-governor motor. Thus the steam generator follows the turbine demand.

Conclusions

Even though the first unit at Portland includes a monotube boiler, which is new in this country; a new turbine design and a new turbine-condenser arrangement; and a combustion control which involves a new concept; it is not expected that the total cost will be appreciably different than if present-day conventional design with the same steam conditions had been followed. The estimated total cost, including land and substation, is $25,902,000 or $157 per kw based on 165,000 kw capacity.

That there will be problems in the initial startup at Portland goes without saying, but these are not expected to be particularly unusual or even appreciably more complicated or difficult than would be encountered with more conventional types of equipment. Based on the past competent achievement of the various suppliers of equipment, there is reason to expect Portland to be in commercial operation within a reasonable time after the initial startup.

The design and construction of Portland station is not a one-man or one-company achievement. The cooperative efforts of the manufacturers, Gilbert Associates, Inc, and the Metropolitan Edison Co have been essential to the carrying out of this project. THE END

References

1. Axial-Flow Exhaust Turbine and Monotube Boiler, by J. G. Miller and R. H. Kreisinger. ASME Paper No. 57-PWR-3
2. Design Features and Development of the Cross-Compound, Single Flow Turbine with Axial Exhaust, by J. E. Fowler and C. Matney. ASME Paper No. 57-PWR-6
3. The Condenser at Portland, by G. T. Jones. ASME Paper No. 57-PWR-14
4. Unusual Features of the Portland Combustion Control System, by E. D. Scutt. ASME Paper No. 57-PWR-8

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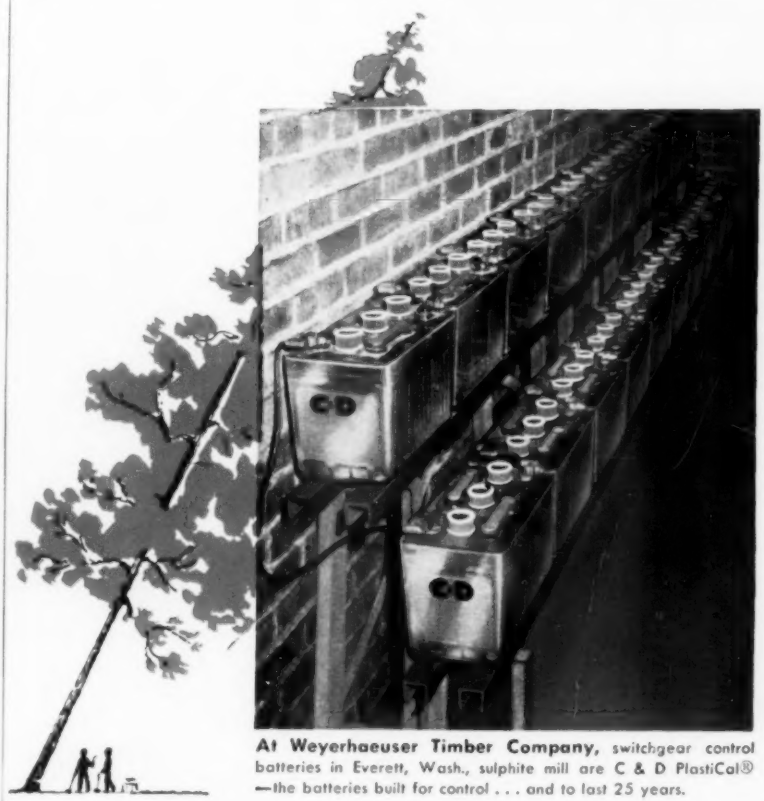

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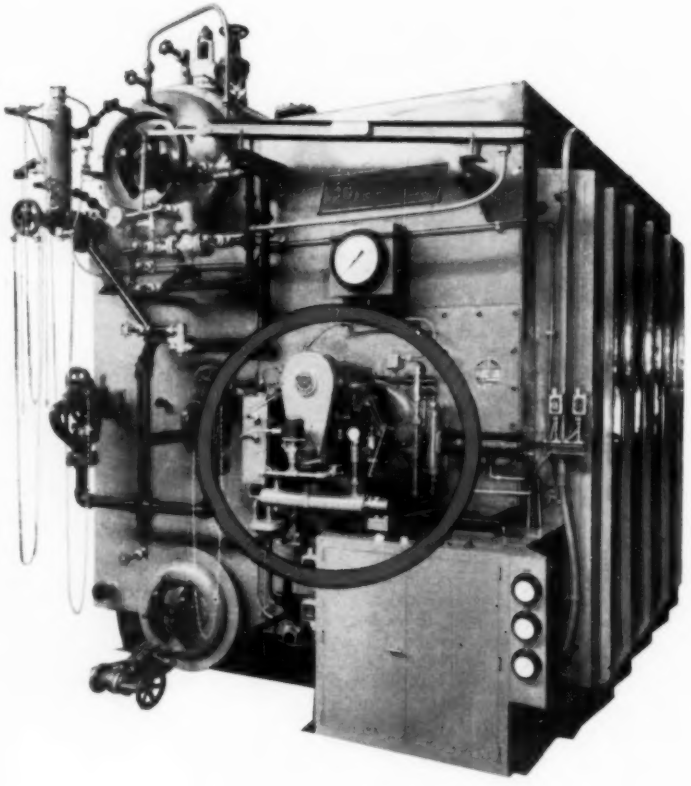

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INSTRUMENTS, CONTROLS

201 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater. Copes-Vulcan Div., Blaw-Knox Co.

202 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

203 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operation, application and construction details of the resistance temperature detectors are presented, along with specifications and ordering tips. Instrument Div., Thomas A. Edison, Inc.

204 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

205 Instruments, Controls — Condensed Catalog 1537 offers brief application information on manufacturer's line of instruments. Fully illustrated, covers draft and pressure instruments, flow meters, liquid levels and pressure gages, CO_2 meters, pneumatic transmitters, positioning operators, temperature instruments, boiler feedwater controls, others. Includes references to detailed literature on each type of equipment. Republic Flow Meters Co.

206 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gauge testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in., pressures from 30 in. vacuum or a few ounces up to 100,000 psi. Manning, Maxwell & Moore, Inc.

207 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, and explains operation. The Reliance Gauge Column Co.

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208 Remote Reading Gages — Eight-pp Catalog 291, revised, shows new designs in remote reading liquid level gages, including the Red Flasher Truscale. This has a scale which flashes continuously in red for a positive warning when boiler water level gets too high or too low. Profusely illustrated with photos and engineering drawings, catalog covers gages in four pressure groups from under 900 to over 1500 psi. Jerguson Gage & Valve Co.

209 Pressure Regulators — Form 1011, on flow regulators, provides selection data with photos on three principal types of main valves and pilots. Also illustrated by line drawings are three suggested applications of regulators. A steam capacity table for the selection of main valve size is also shown. Spence Engineering Co., Inc.

210 Cooling Controls — Bulletin 710B describes company's self-powered cooling controls for compressors, stills, solvent coolers, degreasers, oil coolers, small engines, condensers, others. Includes operational drawing and hook-up sketches. Sarco Co., Inc.

211 Ideas on Push Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

PUMPS, COMPRESSORS

212 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

213 Flow Control — Twelve-pp Catalog 800 describes four basic models of precision proportioning pumps for uses requiring accurate and positive proportioning of flow in range of 0 to 730 gph. Materials of construction, capacities and pressures are shown for each. Diaphragm valves are discussed and their features noted. A section on plastic valves and diaphragms features those for temperatures to 300 F, and includes diaphragm material chart covering selection for use with air, water, corrosives, slurries, liquids, gases. Hills-McCanna Co.

216 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

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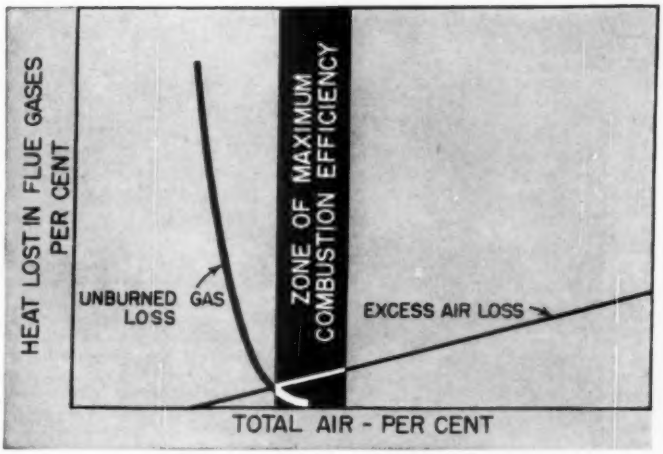
Both instruments measure: (1) excess air—regardless of the fuel or combinations of fuel being burned. (2) mixing efficiency of your fuel burning equipment by showing per cent combustibles in the flue gas.


HEAT LOST IN FLUE GASES PER CENT
UNBURNED GAS LOSS
ZONE OF MAXIMUM COMBUSTION EFFICIENCY
EXCESS AIR LOSS
TOTAL AIR - PER CENT

Maximum Combustion Efficiency is secured by keeping the sum of Excess Air Loss and Unburned Gas Loss to a minimum. To do so by the direct method simply measure both oxygen and combustibles in flue gas.

Both units are designed to increase efficiency in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers and also on direct and indirect-fired furnaces in the metal processing industries.

To prevent your money from becoming waste gas, look into these two efficiency provers. A Bailey engineer will be glad to give you details or write us for product specifications.

For portable use—
HEAT PROVER Analyzer

The famous Cities Service HEAT PROVER analyzer is now Bailey built and sold. Weighing only 25 pounds, it is a self-contained automatic analyzer including a sampling tip and hose plus a thermocouple for temperature measurement.

Instrument dials are dual range for greater accuracy and sensitivity.

For permanent installation
Oxygen-Combustibles Recorder

The Bailey Oxygen-Combustibles Analyzer-Recorder coordinates both records on one chart. These records enable the operator to keep fuel burning equipment performing continuously in the zone of maximum combustion efficiency. Excess air may be reduced to the point where combustibles begin to show.

G 40-1

Instruments and controls for power and process

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215 Steam Pump Care — Bulletin G-2280 "How to Install and Take Care of Steam Pumps," is a 24-pp booklet containing a step-by-step series of 88 illustrations showing how to increase the service life of all types of steam pumps. It offers 28 tips on proper installation of the pumps, 54 tips on care techniques. Section on installation provides information on suction, packing the pump, starting it, and trouble shooting. Section on maintenance deals with such subjects as steam valves, liquid piston and rod, piston packing, liners. Worthington Corp.

216 Non-Clog Pumps — Bulletin 121MV features Mono-Vane single passage impeller pumps designed for handling heavy settleable solids, long stringy solids, effluent etc. Both horizontal and vertical types are presented along with specifications. Mono-Vane impeller is described in detail, and various models of the pumps are pictured. Aurora Pump Div., The New York Air Brake Co.

217 Industrial Air Compressors — Twelve-pp Bulletin A-43 describes company's vertical design industrial air compressors supplying moderate amounts of air on a continuous 24-hr heavy-duty basis. Design features are described and illustrated by means of a cutaway view, and specifications and dimensions are tabulated. Joy Mfg. Co.

PACKINGS, SEALS

218 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing applications. Packing Div., Raybestos-Manhattan, Inc.

219 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross Braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered and a recommendation chart is included. The Belmont Packing & Rubber Co.

You'll save time in ordering bulletins by using the Reader Service Cards on page 102. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

220 Mechanical Seals — Bulletin S-205-2, 8-pp, covers the complete line of chemically inert mechanical seals for handling all types acids, corrosives, solvents and gases. Provides construction, service and application information, installations and engineering details. Crane Packing Co.

MECHANICAL POWER TRANSMISSION

221 V-S Drive Selection Tips — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

222 Internally Geared Power — Featuring latest design improvements in gearmotors and embodying 60 multicolor illustrations, 16-pp Form F-1880 shows comparative advantages of gearmotors, lists ratings from ½ to 30 hp with gear ratios as high as 10:1. Cross-sectional details and enlargements of outstanding features are included, as well as a discussion of use of elliptoidal helical gears, and a chart graphing degrees of tempering of gear teeth. U. S. Electrical Motors Inc.

223 Spherical Roller Bearing — Eight-pp Bulletin A668 describes design and operation advantages of company's Spher-Align pillow block with improved spherical roller bearing. Complete selection data and specifications are tabulated. Dodge Mfg. Corp.

224 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installations, etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use. American Blower Corp.

FUEL BURNING EQUIPMENT

225 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

226 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

227 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

BOILERS, GENERATORS

229 Water Tube Boilers — This 12-pp catalog describes packaged water tube boilers, in capacities from 8000 to 50,000 lb per hour. Interesting as well as informative, this booklet uses color and illustrations to amplify text. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

230 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air. Boiler Engineering & Supply Co., Inc.

231 Shop Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

232 Hot Water Boilers — This 20-pp brochure describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process applications. Combustion Engineering, Inc.

233 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-type boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows details design, and gas travel. Erie-City Iron Works.

234 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data and dimensions for the units. Preferred Utilities Mfg. Corp.

235 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

236 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

ELECTRICAL EQUIPMENT

237 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, including chief features, operating ranges, and applications. James G. Biddle Co.

238 On Copper Conductors — Publication C-25, 62 pp, is designed to help make the selection of bus conductors easier. Included in booklet are tables regarding such shapes as channels, ventilated square tubes and round tubes. There are tables for other rigid bus conductor shapes, also data on bare copper wire and cable as well as commonly used alloy wires. Also provided is a general discussion of copper,

its physical and electrical properties. Photos illustrate many installations. The American Brass Co.

239 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. All information is condensed. Fully illustrated, book gives wiring diagrams, motor tables. Bussmann Mfg. Co.

240 Cable Troughs — This 12-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items, some typical installations and full list of distributors. The Globe Co.

WATER CONDITIONING

242 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

243 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and non-deaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

244 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

245 Feed Water Deoxygenation — The advantages of chemical deoxygenation of boiler feed water with an aqueous solution of hydrazine are described in 12-pp Bulletin BW 5. How hydrazine serves to maintain boiler in cleanest possible condition, reducing iron oxide scale to a magnetic oxide, is fully detailed, and such considerations as economy and operation, handling precautions, storage are covered. Fairmount Chemical Co., Inc.

246 Valveless Filter — Operation of company's automatic valveless filter is described in this 8-pp illustrated bulletin. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

247 Data on Deaeration — This series of bulletins presents company's line of deaerating equipment for removal of dissolved gases from boiler feedwater etc. Publication 4651 describes Jet-Tray deaerators; No. 4652 covers tray-type units. No. 4653 deals with cold water deaerators used primarily to reduce or eliminate corrosion of piping systems, heat exchangers. No.

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0 to 100,000 microhms
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Special clamp type test leads 18 feet long are available on special order. The extra length facilitates tests in elevated or remote locations without moving the instrument close by. Especially important in testing large circuit breakers. Clamps are of duplex type, each makes current and potential connection when applied. This permits one man to make tests.

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4654 describes a surface-type deaerating hot water heater for commercial and institutional use. No. 4643 covers self-contained Uni-Pac deaerators for small and medium size power plants. No. 4635, 12 pp, on atomizing deaerators, details deaeration by atomization and its applications. Cochrane Corp.

248 pH and Chlorine Control — The 12th edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers. W. A. Taylor Co.

249 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising the pH value of the condensate. The Bird-Archer Co.

250 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization at flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

251 On Demineralization — Technical Reprint T-140, 23-pp, a profusely illustrated article on demineralization, discusses advantages and disadvantages of this process for today's power plants. Developments, trends and applications of both multi-bed and mixed-bed ion exchange are considered, and several case histories cited. A comprehensive bibliography lists 119 separate items. Tables, flow sheets, descriptive drawings, performance curves, process selection charts included. Graver Water Conditioning Co.

LUBRICATION

252 Multi-Purpose Grease — This bulletin describes Gargoyle Grease BRB No. 1, intended to provide correct lubrication for practically all normally loaded anti-friction and plain bearings. Tells how it resists leakage, affords protection. Socony Mobil Oil Co., Inc.

253 Lithium Soap Greases — This product information bulletin details qualities and specifications of company's multi-purpose soap industrial greases. Advantages of multi-purpose grease use — such as prevention of lubricant misapplication, simplified maintenance procedures are discussed. Sinclair Refining Co.

254 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

255 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved, in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

VALVES, TRAPS AND PIPING

257 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

258 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and test data is presented to show efficiency of company's silent check valves in water hammer control. Some typical installations are illustrated. The Williams Gauge Co., Inc.

259 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

260 Lubricated Plug Valves — Catalog PV-24, 36-pp, shows in detail a line of iron and steel lubricated plug valves. Many illustrations of the single, screwed and bolted gland type valves are shown, including photos, sectional and detailed drawings. Also included is physical data on dimensions. The Wm. Powell Co.

261 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

262 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

263 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

264 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. Photos, drawings and diagrams amplify the text. The Henry Pratt Co.

265 Valve Digest — Form 197R is a valve catalog digest furnishing the latest coverage of the OIC bronze, iron, cast steel, forged steel, and lubricated plug valve lines in a condensed form. Valves are classified by type and pressure class, and illustrated; this edition also includes face to face dimensions for each size and type of valve listed. The Ohio Injector Co.

266 Impulse Steam Trap — Bulletin T-1742, 8 pp, describes a line of impulse steam traps designed for a variety of trapping requirements. Contains information on operation, materials and capacities and includes dimensional and specification data, as well as photos of typical installations. Yarnall-Waring Co.

267 Trap Service Guide — To promote better trapping practice, pocket-size 32-pp Bulletin 7511 offers practical tips on installation, testing, and maintenance. Chapters are devoted to inspection and repair, trouble shooting, parts identification. Capacity charts are provided, also tables showing interchangeability of company's trap parts. Other sections deal with strainers, check valves, automatic trap drains. Armstrong Machine Works.

268 Insulated Piping—Bulletin 57-1, 24 pp, on prefabricated insulated piping systems, shows typical uses for Hel-cor pipe units for underground or overhead pipe systems. Also describes Utilidor conduits for protection of underground utility services. Sample specifications are given, along with conduit sizing charts. Ric-wil, Inc.

269 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austenitic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

TUBING AND ACCESSORIES

270 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

Postage-free cards for ordering catalogs are on page 102. You may also use the cards to order literature mentioned in the ads.

271 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

272 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes, ordering tips and distributors. The Gustav Wiedeke Co.

CORROSION CONTROL

274 Corrosion Control. — Treatment of industrial equipment to control corrosion cannot be a hit-and-miss proposition cautions this 6-pp folder. Examples are given of optimum control measures that may avoid costly, unsound treatment procedures, including minor physical or operating changes. Hall Laboratories, Inc.

275 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

276 Guide to Corrosion Prevention — How Bitumastic protective coatings aid in fight against corrosion is told in this 12-pp booklet. Discusses corrosion as a universal industrial problem, role of protective coatings in cutting costs and lengthening service life of structures and equipment, and gives data on several coal tar-based coatings intended to solve a variety of corrosion problems. Twelve typical case histories covering use of these coatings in varied industries described. Koppers Co., Inc.

REFRACTORIES, INSULATIONS

277 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2,500 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Universal Atlas Cement Co.

278 Refractory Castable — Bulletin R-10 describes use of Kaocrete-32, a high temperature refractory castable, in boiler ashpits. A discussion of various methods of ash removal, along with maintenance problems peculiar to each, is presented. Four typical installations are detailed. Refractories Div., The Babcock & Wilcox Co.

279 Insulations, Refractories — This 20-pp catalog features thermal insulations and refractories for general industrial applications. Organized for quick reference, catalog provides information on composition, physical and thermal properties and sizes of the various products. Lists chief advantages, covers materials for efficient control of temperatures from −400 F to 3000 F. Johns-Manville.

280 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high tempera-

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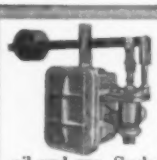

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A valve for many different services, simple in construction, accurate in operation. Single seat, pilot stem. Tight closing, no water hammer, non-sticking. No internal packing. Sizes ½" to 12". Brass or semi-steel bodies, pressures to 125 lbs. hydraulic.
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ture work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

281 Duct Insulation — Engineering data and application instructions for company's semi-rigid, spun mineral wool duct insulation are presented in this informative bulletin. Thermal and sound absorption characteristics are presented in tabular form and physical, chemical, mechanical properties given. Baldwin-Hill Co.

282 Underground Pipe Insulation — This illustrated bulletin discusses the problems of underground pipe insulation and explains how company's insulation for hot underground pipes overcomes them. On-the-job photos illustrate ease of application; brief technical data are also included. American Gilsonite Co.

OTHER EQUIPMENT

283 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

284 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

285 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

286 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

287 Steel Floor Plate — Skid resistance and other advantages of multigrip rolled steel floor plate are stressed in this illustrated bulletin. Also gives dimensions, weights, and information on allowable loads. United States Steel Corp.

288 Metal Laminates — Types of metal laminates, metals which can be laminated, and use in heat exchangers, electronics and other applications are detailed in this illustrated 8-pp bulletin. Advantages and properties are described, and size data given. Bridgeport Brass Co.

289 Product Guide — This illustrated 8-pp bulletin contains descriptive information on company's industrial products division and the products it manufactures, including power plant equipment, bridges, pressure vessels, process industry equipment and a wide variety of specialized products. Describes manufacturing facilities and includes production photos of manufacturing processes. Industrial Products Div., Maryland Shipbuilding & Drydock Co.

290 Ejector Data — This 12-pp bulletin presents company's steam jet air ejectors designed for efficient, low cost air removal from condensers. Illustrates basic ejector assembly, and discusses principle of operation. Single- and multi-stage units are shown. Also described are steam jets for special services and air ejector accessories. Engineering data pertinent to ejector application in power plants, process plants and evaporators included. Condenser Service and Engineering Co., Inc.

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293 Refrigeration Condensers — Engineering data on a complete range of sizes and types of refrigeration condensers are featured in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers. Selection data, dimensions, dimensional diagrams and tables of pipe sizes given. Henry Vogt Machine Co.

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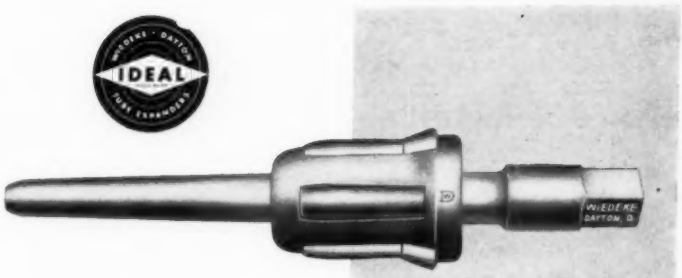
295 Sectional Condenser — Bulletin 131 shows benefits of sectional-design refrigeration condensers for 100 to 240 tons refrigeration capacity and explains their functions with diagrams and installation photos. A cutaway shows component parts. Niagara Blower Co.

296 On Coal Burning Plants — Presented in this illustrated 20-pp booklet, "More and more firms are burning coal the modern way . . ." are eight case histories of notable coal burning plants. They include industrial, commercial and institution power plants, both modernization and new construction. Economy and other advantages of coal as a fuel are stressed. Bituminous Coal Institute.

297 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data rating tables, performance charts. Buffalo Forge Co.

298 Overhead Heating Units — Bulletin P 1-57, 16-pp, contains photographic reproductions of overhead gas-fired heaters, as installed in a variety of commercial and industrial plants. How this type of heating was used to solve specific heating problems is detailed. Prat-Daniel Corp.

299 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.



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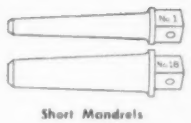

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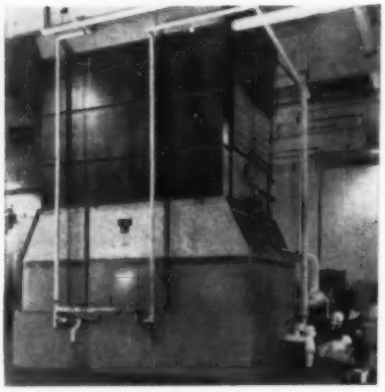

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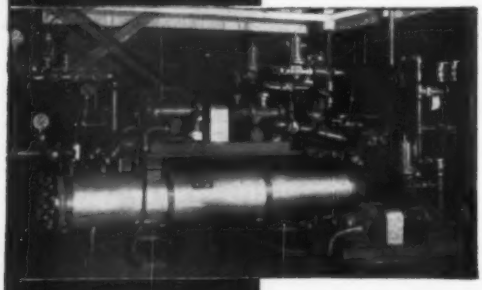

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Water Analysis Unit

continued from page 77

valves are switched again, the flow is in the opposite direction. These pumps are highly accurate, but require suction pressure at least 10 lb per sq in. higher than discharge pressure. The sample supply is controlled at about 10 psi pressure, by a back-pressure valve which permits a small flow to drain continuously.

Thus during each cycle, the analyzer measures a fresh sample and not one that has been dead-ended in the piping. To provide the necessary pressure on the reagents, the analyzers use small accumulator type pumps that mount directly on the reagent bottles.

Industrial Application Extras

In developing the analyzers, the designers were aware of the requirements of American industry for rugged equipment with long service life and minimum maintenance. The analyzers are built in two units — one housing the analysis equipment, while the other houses the recording and controlling circuits. Preferably, these two units are mounted together but they may be separated by as much as 50 feet. Unitized construction with easy plug-in assemblies permit quick replacement when necessary. The glass windows of the cells are easily removed so that the cells can be cleaned without disturbing other parts of the instrument.

Analyzers in Control Circuit

These instruments are designed to improve the control of water treatment facilities, whether the need be for alarms or an automatic control system. The recording units are equipped with *high-low* limit switches which can be used to actuate alarms such as horns, bells or lights. The switches are adjustable over the entire range of the instrument, and can also be used to start programmers for regeneration of a demineralizer.

In a typical completely automatic control system for a demineralizer, the high alarm switch is set for a silica concentration of 0.02 ppm, and whenever the silica content in the boiler make-up water exceeds that amount, the switch closes an electrical circuit that starts an external program timer. The timer, in turn, actuates solenoid valves and lights which control and indicate the position of pneumatically operated valves.

With the valves opened and closed automatically in sequence, the demineralizer can be regenerated and returned to service without the operator having to touch a button. His primary duty will be supervisory, and he will be expected to step in and take over if unforeseen difficulties should ever develop. The automatic analyzer is the link that closes the control loop, and makes completely automatic water treatment possible.

These colorimetric analyzers are manufactured with two standard ranges - - 0 to 3 ppm and 0 to 5 ppm, calculated as calcium carbonate. The instruments have sensitivities of 0.03 and 0.05 ppm, respectively.

The silica analyzers have standard ranges of 0 to 0.5 ppm, and 0 to 50 parts per billion (0.05 ppm), calculated as silicon dioxide. The higher range instrument is accurate to within plus or minus one per cent, while the instruments with the latter range have an accuracy of plus or minus five per cent. These are the ranges which have been found to be most useful for controlling boiler water treating facilities; however, the manufacturer's engineers are prepared to develop the analyzers for other ranges if needed. Their new design specifications call for dissolved-iron analyzers, with a range of 0 to 100 ppb, a phosphate analyzer with a range of 0 to 20 ppm, and a dissolved-oxygen range of 0 to 15 ppm.

Not knowing what chemical, optical or electronic problems may arise in the development of the additional ranges, the manufacturer cannot predict when the first units will be in the field. The hardness and silica analyzers have been operating satisfactorily in power plants for six months. For more information write the Editor, or jot Water Analyzer on the enclosed Inquiry Card. THE END

NEW ENGINEERING BOOKS

Cooling Tower Institute: Specifications, and Interim Report, by technical committees of the Institute. First Edition of Technical Bulletins Nos. STD 103, WMS 104, and ATP 105, 1956. Less than 10 pages each, 8½ by 11 in., paper. Published by Cooling Tower Institute, 446 Emerson St, Palo Alto, Calif. Prices: $1.00, 1.50, and 1.00, in order listed.

In September, 1955, POWER ENGINEERING published an article based on information contained in four bulletins released by the Cooling Tower Institute. The response from our readers was so enthusiastic we believe they will be interested in these more recent bulletins. Specifically, STD 103 is a recommended set of standards for Redwood Lumber, and design data for frameworks of towers; WMS 104 is an interim report of the committee studying the maintenance of wood in cooling towers; and ATP 105 recommends Standard Specifications for Acceptance Test Procedures for mechanical-draft towers.

Bulletin STD 103 supersedes STD 101 and 102, both dated May 1, 1955; bulletin ATP 105 supersedes TSC 101 and ATP 105 dated July 27, 1955. These latest bulletins present, in clear and concise form, those specifications mentioned, and the findings of the committee investigating the cause and prevention of wood failure.

Of particular interest to the power engineer who is concerned with operations and maintenance is the recommendations as to chemical and bacteriological control of water, to reduce wood corrosion in towers.

* * *

Fundamentals of Combustion or Gaseous Fuels, by S. A. Weil, R. T. Ellington, E. F. Searight, and S. Hu. Size 8½ by 11 in., paper cover, 64 pages. Research Bulletin 15, published by the Institute of Gas Technology, Technology Center, Chicago 16, Ill. Price $5.00.

This bulletin is the result of an extensive search of the literature on the theory of combustion, combustion phenomena, experimental investigations of various phases of combustion, and certain fundamentals important to burner design. Over 1000 references were consulted, and some 200 have been critically reviewed. The more significant findings and opinions are summarized. The study was sponsored by the General Research Planning Committee of the American Gas Association.

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BULLETIN No. 31

HOW TO SOLVE

PIPE EXPANSION PROBLEMS

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6. Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.

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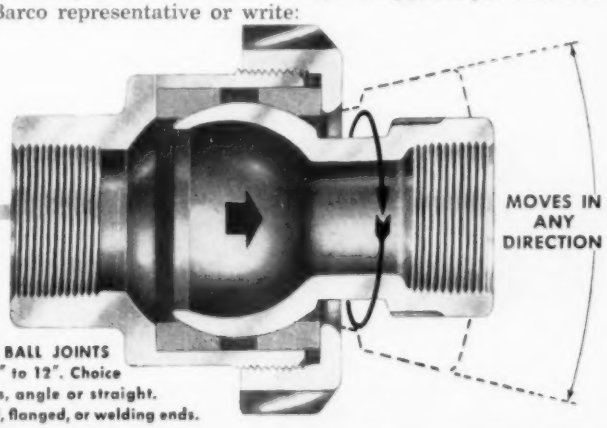

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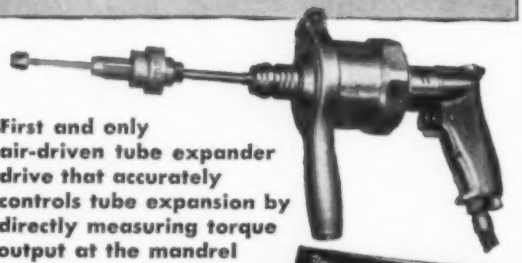

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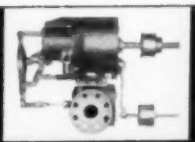

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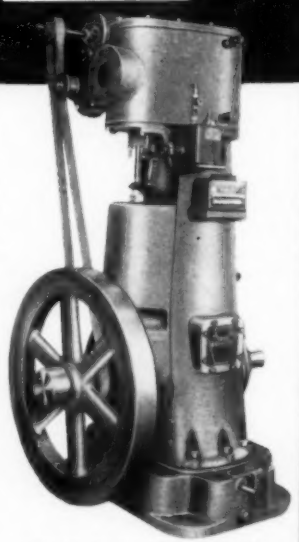

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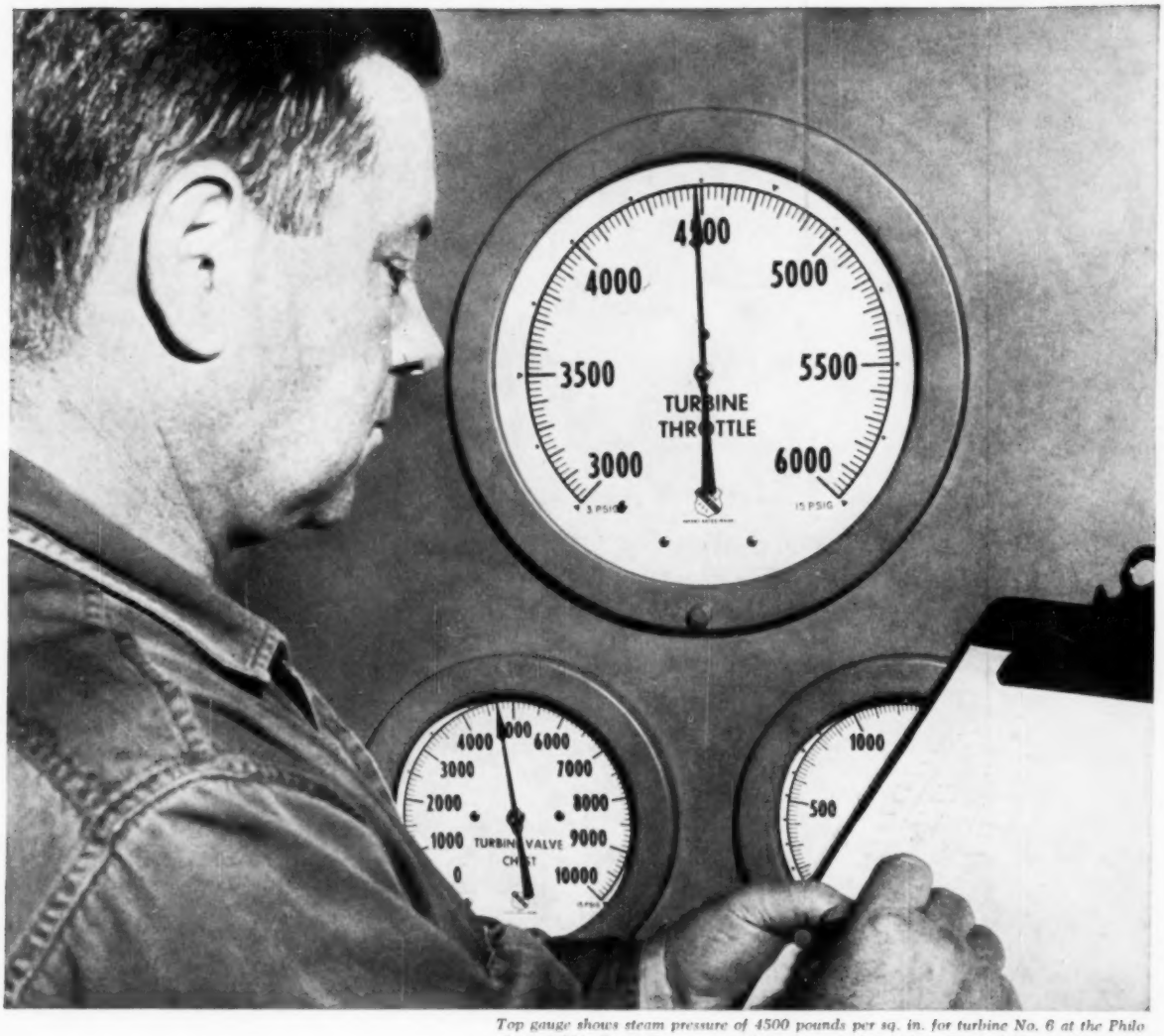

Top gauge shows steam pressure of 4500 pounds per sq. in. for turbine No. 6 at the Philo plant of Ohio Power Co., an operating company of American Gas and Electric Company.

New "super-pressure" steam unit requires ultra-pure water

● The higher its temperature and pressure, the more work steam will do for each pound of fuel you use. That's why power-plant steam pressures have been steadily climbing. First "super-critical pressure" unit is No. 6 in the A. G. & E. System's Philo Station. It operates at the tremendous pressure of 4500 psi (almost double previous "highs") and at a new high temperature of 1150°F.

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